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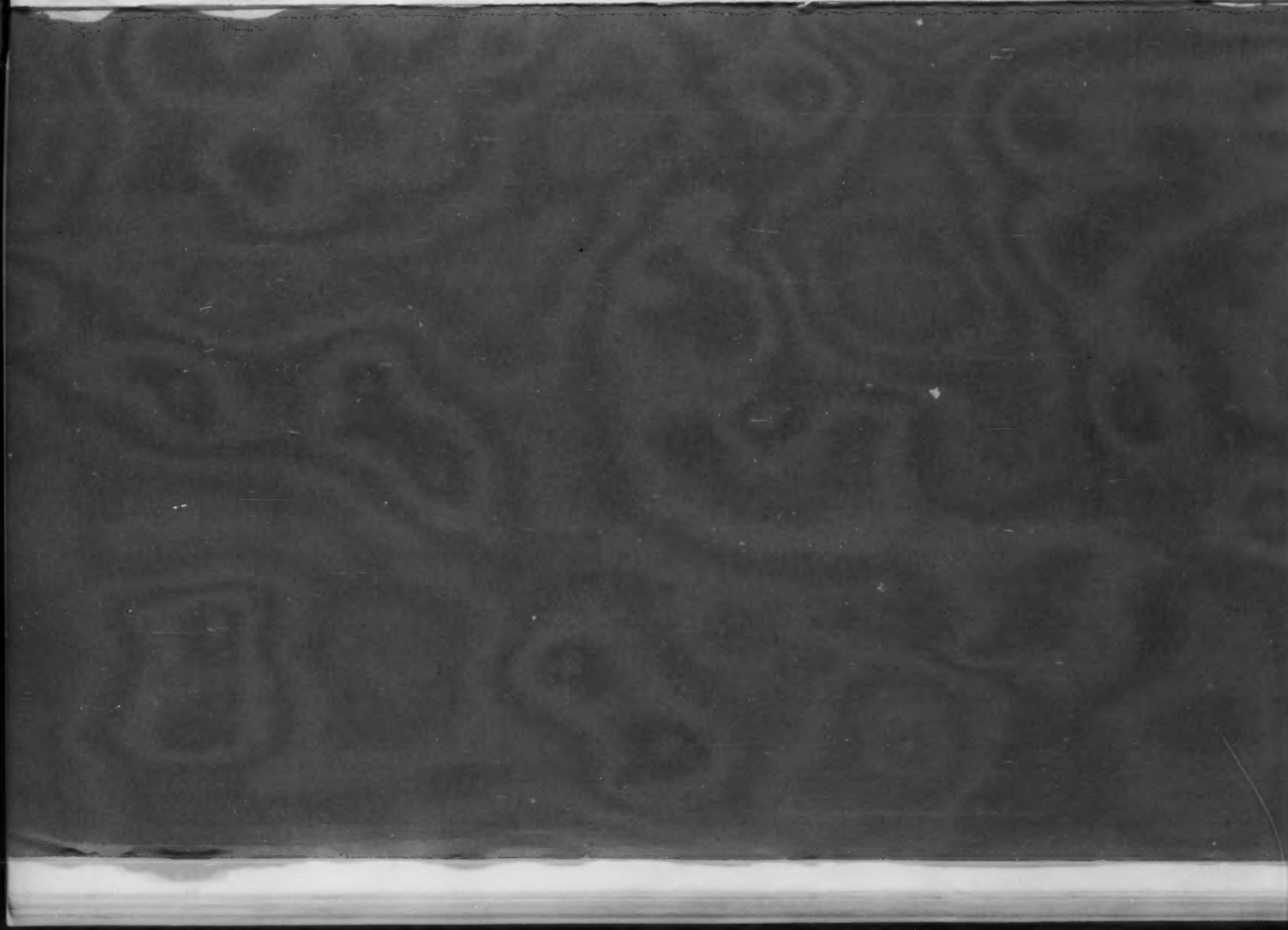
The Geographical Review

PUBLISHED BY

THE AMERICAN GEOGRAPHICAL SOCIETY
OF NEW YORK

NOVEMBER

1920



THE
GEOGRAPHICAL REVIEW

VOL. X NOVEMBER, 1920 NO. 5

THE PORT OF PARIS

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The Seine has been associated with the life and fortunes of Paris during the entire recorded history of the city. The river not only served as a defensive barrier to the new and growing town, surrounding the island on which it was situated, but early fostered in its inhabitants an instinct for traffic and commerce by water.

Long before the Roman period a stream of commerce poured through the valley of the Seine, coming up from the Mediterranean through the Rhone Valley and ending on the shores of Great Britain, where, as everyone knows, the ancient world obtained the greater part of its tin. During the first century of our era there existed in Paris a wealthy corporation of boatmen, the *Nautae Parisiaci*, who occupied themselves exclusively with shipping on the Seine. With the decline of the Roman Empire the Seine lost its prestige as an international trade route and as such disappeared from Continental history for several hundred years. Nevertheless, as Paris grew in importance the river contributed materially to its development. The Seine was of such consequence to the city that as early as the twelfth century the "water merchants" formed one of the richest corporations of Paris with special privileges granted them by the kings of France. By the middle of the fourteenth century this corporation was at the head of the municipal administration; its arms and motto, "Fluctuat nec mergitur," had been adopted by the city, and the corporation's chief had become the chief civil official of the municipality.

For hundreds of years it was the Seine that fed Paris. Food supplies and construction materials came by water. In the seventeenth and eighteenth centuries, after the building of the great royal roads, the rôle the river played diminished somewhat in importance, but it remained preponderant nevertheless, and the most animated marts of trade and barter were always those on the water front. At the beginning of the nineteenth century the

railroads began to make serious inroads on the traffic, many foodstuffs came by rail, the markets were moved from the Seine to quarters nearer the centers of the city and more accessible to the consumers.

In spite of these changes the Seine traffic continued to be an important factor in the city's economic development. Paris, steadily enlarging, outgrew its walls, overran its suburbs, invaded lands once on its very outskirts, and became one of the great urban agglomerations of the world. The growth of the port of Paris corresponds with the growth of the city; it is now the port for a region of 4,000,000 inhabitants; its traffic (15,228,085 metric tons) surpassed in 1913 that of Marseilles (8,938,652 metric tons), the greatest maritime port of France.[1] These figures are based on the traffic within the confines of the Department of the Seine alone. If one considers that Greater Paris really includes many districts at some distance from, but still under the influence of and in direct contact with, the metropolis—in other words it extends upstream as far as Corbeil (31 kilometers) and downstream as far as Bezons (32 kilometers)—the sum of the volume of traffic rises to the enormous total of 27,000,000 tons.

Subdivisions of the Port of Paris

Most well-informed people are aware of the importance of the port of Paris, but many of them would be at a loss if asked to define its exact boundaries. Paris has no distinct harbor district as other ports have, rather there are many harbors in many districts scattered along the course of the river and its canals. The river traffic is not concentrated; there is no one dominant group of docks, wharves, warehouses, etc.; on the contrary the traffic is widely dispersed along the shores. It is essential, therefore, to consider what may be called the geographical subdivisions of the port of Paris; and for a clear understanding of these one must bear in mind that the port began with the city and developed continuously with it.

There are three distinct sections or districts which have gradually become merged into one system as the city has grown and expanded. These three districts are: (1) the Seine within the city limits, (2) the Seine in the suburbs, (3) the canals of the city.

The Seine Within the City

The intramural course of the Seine is 12.3 kilometers long, and a considerable portion of both banks is used for the loading and unloading of freight cargoes. There are fewer wharves and slips in the center of the city, and they are small and narrow. Through the quarters of Notre Dame, the Palais de Justice, the Louvre, and the Tuileries, the river flows tranquilly between stone quays surrounded and topped by tall buildings and monuments. But upstream and downstream such structures no longer

[1] In 1918 the traffic of the port of Paris reached a volume of 12,784,343 metric tons.

crowd to the water's edge; there is more room for factories, for trade, and consequently for the river traffic. So it happens that commerce on the waterway tends to the outlying quarters, particularly to those upstream. More than 14 kilometers of the banks have been devoted to wharfage. On the right bank are the quays of Bercy, La Râpée, Henri IV, Célestins, Hôtel de Ville, Louvre et St. Nicolas, Tuileries et Concorde, Champs Elysées, Conférence, Debilly, Passy, and Auteuil. On the left are Tolbiac, Gare, Austerlitz, St. Bernard, Tournelle, Montebello, Orfèvres, Saints-Pères, Solferino et Orsay, Invalides, Gros-Caillou, La Bourdonnais, Suffren, Grenelle, and Javel. It is a constant source of amazement to those who go to see the Seine at Paris to find that at almost every group of piers building materials are being unloaded—sand, gravel, stone, and brick. This is because the city, constantly growing, spreading out, changing, has to have a landing place in every separate quarter for the heavy building materials that are constantly required. In addition to this, however, each group of wharves belonging to each quarter of the city specializes in some particular article of commerce. Bercy handles wine; La Râpée coal, wood, and paper pulp; Louvre et St. Nicolas is given over to merchandise brought from England by small coasting vessels; La Gare to casks and petrol; Austerlitz receives a varied assortment of goods in its stores and warehouses—precious woods, boxes, castings, marbles, machinery, grains, preserves, sugar, and wheat; St. Bernard, like Bercy, handles wine; Javel, coal and refuse. These intramural docks ranged in a series along the city's banks disposed in 1913 of more than one-half of the entire amount of merchandise loaded and unloaded in the entire system of Paris ports that year, more than 6,700,000 tons.

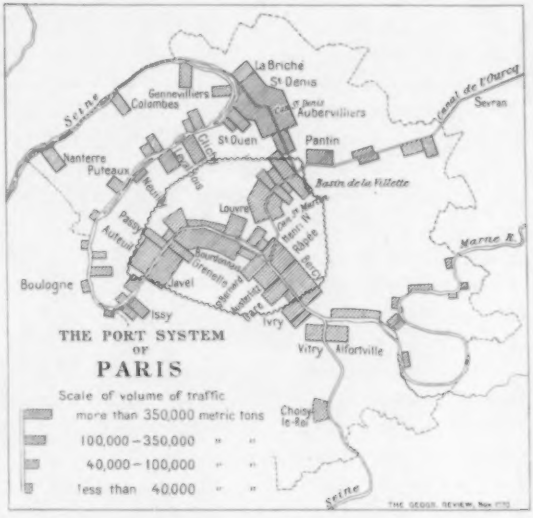

FIG. 1—Sketch map representing the volume of water-borne traffic at the subdivisions of the port of Paris in the Department of the Seine. Paris has no special harbor district: traffic is dispersed along the banks of the Seine both within the city and in the suburbs and along the tributary canals. Scale of map approximately 1:3,900,000.

THE CANALS OF PARIS

During the eighteenth century Paris grew towards the northeast, beyond the *faubourgs* of St. Denis, of St. Martin, and of the Temple. Groups of

houses sprang up in the direction of La Villette, between the heights of Montmartre and Belleville. These newer parts of the city lay away from the water front. To keep them in communication with the river it was decided to build an artificial waterway, and a canal system was laid out comprising the St. Denis Canal (6,750 meters in length), which was completed in 1821, and the St. Martin Canal (3,200 meters in length), completed in 1825. A third canal, that of the Ourcq, planned primarily to furnish water to the other two, was opened in 1826 and made into a navigable channel. Thus a complete circuit was established, from the lower Seine at La Briche near St. Denis, to the upper Seine in Paris at the Arsenal basin, connecting with the waters of the Ourcq Canal at the Villette basin. The system comprising these three canals is called the Municipal Port, because it belongs to the City of Paris. These canals go through the busy industrial sections, among the factories and workshops. The beautiful views along the Seine find no rivals here; here are no monuments and gardens, no delightful walks shaded by ancient trees; here are only prosaic and utilitarian objects, sheds and warehouses, mills, cranes, coal yards, wood yards, piles of stones and of sacking. The Villette basin at the junction of the canals carries a traffic of more than 1,000,000 tons. Districts of wharves and piers succeed each other along these waters; on the Ourcq Canal lie Pantin, Bobigny, Noisy-le-Sec, Bondy, Pavillons; on the St. Martin Canal Pantin, Combat, Récollets, Marais, Arsenal; on the St. Denis Canal Flandre, Aubervilliers, Stains, St. Denis. In 1913 these waters carried over 3,000,000 tons of freight, principally coal destined for the use of the mills and factories in these quarters and in regions contiguous to them.

The Seine in the Suburbs

As the Parisian population spread out far beyond the city's walls the port of Paris extended itself also, above and below the town. Many factories driven from the city proper by the increasing value of the land, moved into the suburbs, as close as might be to the Seine where they could receive their raw materials and coal by water. Thus the third distinct division of the port developed: upstream, St. Maurice, Joinville, Choisy-le-Roi, Alfortville, Vitry, Ivry; below, Billancourt, Boulogne, Issy, Sèvres, St. Cloud, Suresnes, Puteaux, Neuilly, Courbevoie, Levallois, Clichy, Asnières, St. Ouen, St. Denis, La Briche, Gennevilliers, Colombes, Nanterre. These landings, which are principally used for industrial supplies, have a volume of traffic of some 3,000,000 tons.

Projected Improvements

Plans are being made for further extensions of the port. It is probable that in the near future the Parisian waterways system will have added to it a great canal from the Marne, designs for which have been almost completed by the engineers in charge. The scheme is an attempt to avoid the troubles incident to the Seine floods.

The canal is to start from the Marne, near Annet north of Lagny, is to pass Claye, Sevran, Aulnay-sous-Bois, and to enter the Seine at St. Denis after a course of 34 kilometers. It will have a flow of 500 cubic meters a second from the waters of the Marne and will thus lower the flood level of the waters in Paris by 1.5 meters for a great inundation such as that of 1910. It will not only lower the high-water levels of the great floods but will entirely do away with the effects of the smaller freshets which disturb navigation yearly. And above all it will open up to the north of Paris a direct route by which vessels may avoid the tortuous and difficult journey through the city and which will enable the Lorraine ores and the coal from the Sarre region to be shipped directly to the port of Gennevilliers below Paris. This port is another projected improvement which will add greatly to the volume of river traffic. It is to be excavated in the alluvial deposits of the Seine westward of Paris, and is to be brought into relation with the network of railways comprising the Western and Northern railway systems. There are to be two basins, one for trade and commerce, the other for the factories which will be built there. It will be the great downstream harbor, the port for the maritime traffic that will come up the Seine when its channels are deepened. Seagoing and inland-waterway vessels will transship cargoes there, as they now do at Rouen, and there will be in addition a great volume of freight from eastern France, coming down by river boats to be transferred there to ocean-going ships.

To sum up, the port of Paris is divided into three distinct parts: (1) the river within the city itself, carrying about half the traffic; (2) the river in its course through the suburbs, carrying about a quarter of the traffic; (3) the canals, which carry about a quarter of the traffic. The port extends along the Seine for some 53 kilometers, from Choisy-le-Roi to Nanterre, and for 14 kilometers more through the canals of the town, 67 kilometers of waterways in all, on which were carried, in 1913, 15, 288,085 tons of freight.

The Seine As a Waterway

The characteristics of the Seine as a waterway are clearly reflected in the long history of navigation on the river from the earliest days to the remarkable development of an inland merchant marine during our own era. Of all the rivers of France the Seine is the one whose system of waters is best adapted for constant use as a means of communication. The topography of the Seine valley is such that it lends itself better than any other valley in France to connection with other basins and to the extension of its waterways. Of all the regions of France the district about Paris is the one where man has most employed his art and skill in altering and improving navigable streams.

The Character of the Seine

The Seine is notable among French rivers for its tranquil, steady flow. While other rivers pour down from mountain heights, the Seine, rising at

an altitude of only 470 meters, runs into a shallow basin of but slight inclination. At Paris, 180 kilometers from the sea, the Seine is but 25 meters above sea level, the grade to the ocean thus being only 7 centimeters per kilometer; whereas on the Loire between Ponts-de-Cé and Nantes the grade is 16 centimeters per kilometer and on the Rhone between Lyons and the sea, 45 centimeters. Consequently the waters of the Seine flow quietly, without turbulence; and even in times of flood they rise slowly, not suddenly. The rainfall too is distributed with comparative regularity throughout the seasons of the year. Paris does not suffer from seasons of drought as do the Mediterranean shores and, on the other hand, has few torrential downpours to score the earth and flood the streams. Three-quarters of all the land in the Seine basin—59,210 out of 78,650 square kilometers—is permeable soil, hence the greater part of the rainfall filters through and feeds the springs which in turn keep the rivers supplied with water during the summer season. The Seine has less reason than the Loire to fear summer drought.

The Seine deposits little alluvium, there are no sand bars or gravel banks impeding the course of the stream as there are along the Loire, and its channel is a fixed one, not varying with every freshet. Thus, given a slight incline, a regular flow throughout the year, and a clear channel, the Seine was naturally from earliest times a superlatively safe and useful watercourse, an invaluable artery of commerce and intercourse for the entire region. This very fact makes the more serious the exceptional accidents—floods, drought, or frost—that from time to time interfere with navigation. In more recent years engineers have devised various means for controlling the waters. Dams have been erected between Paris and Rouen, the level of the low water has been raised, there is no longer danger from a possible drought. But attempts to regulate the high water from upstream have not been so successful, though it is hoped that the floods too will soon be under control.

Connection With Other Basins

The commercial value of the Seine is greatly enhanced by the fact that it can so readily be connected with streams in neighboring basins. The bordering elevations are slight, it is easy to cross to the Loire, to the country around the Meuse, the Moselle, the Rhine, and the Scheldt. A complicated system of communications has gradually developed, radiating from Paris. It was France that built the first canals in all Europe to cross divides, connecting basin with basin. The earliest ones were planned to secure provisions for the city. The first canal system joined the Seine and the Loire; the Briare Canal was opened in 1642, the Orléans Canal in 1692, the Loing Canal in 1721. Thus as early as the seventeenth century Paris was in direct communication with the districts about the Loire, rich in grain and wine. But it was not until 1822 that the canal that paralleled the upper Loire and was to bring Paris coal from St. Étienne was begun, and this was not completed until 1856.

A second system of canals united Paris and the northern country. The St. Quentin Canal, 1724–1810; the canal paralleling the Oise, 1831; the canal from the Sambre to the Oise, 1839; the Ardennes Canal, 1835. Of all these engineering developments the finest and most useful was the St.

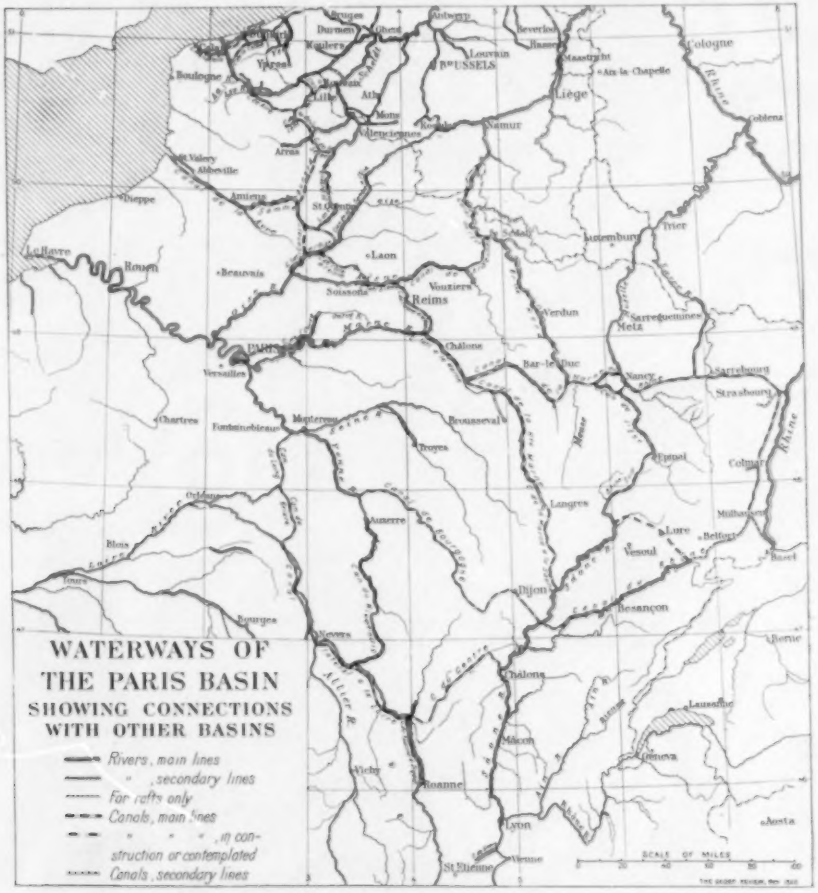

FIG. 2—Map showing the waterways of the Paris Basin and its connection with adjoining basins. Scale 1:5,000,000.

Quentin Canal, between the Somme and the Scheldt, which was designed to connect the coal fields around Valenciennes with Paris. In constructing this canal it was found necessary to drive two tunnels through chalk, one 5,670 meters long at Riqueval, one 1,098 meters long at Tronquoy. For a number of years and as late as 1831 the greatest difficulty was experienced in making the bed of the canal water-tight, for the waters drained out constantly through the permeable rock. But when the work was finally

completed it was a fine stretch of waterway, admirable for its time, through which enormous quantities of coal could be brought down to Paris and all its industrial outskirts. These shipments of fuel have now grown so great that the St. Quentin Canal is shortly to be duplicated by the Northern Canal now in the course of construction.

A third system of canals connected the Seine with the country to the eastward—the Bourgogne Canal (1832), between the Yonne and the Saône, and the Rhine-Marne Canal (1853). By means of these Paris was able to draw upon districts at a greater distance for its provisions of wine, wood, and building materials.

Improvement and Standardization of the Waterways

The capacities of the waterways that carry the shipping of Paris have been greatly increased by extensive engineering work on the rivers and canals. Everywhere natural conditions have given way to the needs of commerce, and man's efforts in this direction, accomplished at the expense of much labor, are not yet completed.

The adoption of the standard gage gave the railways their greatest advantage. A car could travel over the lines of any company from one end of the country to the other. The canals and rivers of France on the contrary were handicapped by the diversity of their dimensions. Built at different periods, according to the necessities of the time and the place, and with resulting variations in depth, locks, and general construction, the canals were totally inadequate to meet the needs of a growing volume of traffic stimulated by the rapid expansion of urban and industrial life. In 1879 the Freycinet laws were passed requiring certain uniform dimensions along navigable waterways—depth 2 meters; width of locks 5.2 meters; inside length of locks 38.5 meters; clearance under bridges 3.7 meters. 'These laws adapted French waters to the measure of the Flemish pinnaces of 300 tons' burden that brought coal to the Villette basin in Paris. These dimensions were adhered to in remodeling the principal canal systems, the St. Quentin and the Sambre-to-Oise Canals which connect Paris and the North; the Marne-Rhine Canal and the river Marne connecting eastward with Alsace and Lorraine; the upper Seine and the Bourgogne Canal connecting Paris to the southeast with Lyons; the Briare and the Loing Canals connecting with the districts to the southward which in turn are served by the Loire and the Central Canal. Paris was thus put in direct communication with the coal mines, with the industrial centers, and with the forest regions of France which lie beyond the Seine basin.

Connection With the Sea

But it was still necessary to connect Paris with the sea and to give her access to that universal highway. The Seine reaches the English Channel by Rouen and Havre, but this natural route did not meet modern needs.

The channel of the Seine varied greatly, deeps alternating with shallows impassable in times of low water. At the beginning of the nineteenth century it was quite usual to harness up from thirty to forty horses to drag the ships through the worst places (Bezons, Poses, Martot). In earlier days these inconveniences were tolerated, but they became unendurable when the necessity for a rapid and regular traffic began to develop. Toward the middle of the nineteenth century it was decided to build dams and locks in the shallow places so as to raise their levels. From 1832 to 1866

FIG. 3—The Seine at the beginning of the seventeenth century. View from an old engraving. Looking up stream: on the right Ile St. Louis; on the left the buildings of the Arsenal. The island in the center where cargoes of wood are being discharged is now attached to the mainland and is occupied by the quai Henri IV.

there were built seven locks between Paris and Rouen (Suresnes, Bezons, Andrésy, Meulan, La Garenne, Poses, Martot) giving eight reaches where vessels could be sure of an anchorage depth of 1.6 meters. These first improvements were soon outgrown and a second series begun. From 1879 to 1888 under the operation of the Freycinet laws two more locks were added, and the anchorage depth of the Seine waters was increased to 3.2 meters from Port-à-l'Anglais (4 kilometers above Paris) to Rouen, 250 kilometers in all. Lighters of 1,000 tons' burden could then pass up and down the Seine. To permit this traffic direct entry into Paris the waters of the St. Denis Canal and the Villette basin were also given a minimum depth of 3.2 meters. These improvements gave an astonishing impetus to traffic on the lower Seine; from 1881 to 1911 shipping on the river from Rouen to the confluence of the Oise increased from 933,600 tons to 3,777,600 tons. The time has now come, however, when further changes are imperative and

the establishment of direct relations between Paris and her oversea trade is necessary. This need has given rise to the various plans known to the public at large by the general title of the seaport-of-Paris projects.

Up to the present time the best known of these projects has been that of the engineer Bouquet de la Grye (1880). His scheme was to dredge the Seine to a depth of 6.2 meters, to have six reaches between Rouen and Paris, to build cut-offs across some parts of the winding stream, to straighten some of its curves, and to raise the bridges. This plan was abandoned as being too expensive. The floods of 1910, however, called the public's attention again to the work along the Seine, and with the idea of preventing future disastrous inundations in Paris and its environs the Commission proposed that the Seine channel should be deepened to 4.5 meters between Paris and Bougival. Immediately the question why this improvement should be limited to the neighborhood of Paris was raised. Why indeed not continue the excavation of the channel as far as Rouen? Paris has championed this idea in the face of hesitation and doubt on the part of the Ministry. The city realizes that river barges of 2,500 tons, seagoing barges, and even coasting vessels could come directly up the river, that all this traffic could be accommodated in the artificial harbor of Gennevilliers just below Paris, and that thus Paris would be brought into her desired contact with ocean navigation.

Port Facilities

Deepening the channel will not be the only problem. The banks of the river must be provided with suitable facilities for the reception and expedition of cargoes. These installations will require considerable planning. It is not as if this were a new land where every project could be put through without any other considerations. As in all old countries the past hampers men, and the city is not free to develop its port at will.

The great advantage of the port of Paris is that its ramifications extend throughout the very heart of the city and that it offers an unusual amount of wharfage for the accommodation of vessels. In its course through the city the Seine becomes in reality an artificial waterway entirely controlled by man. Islands have been connected with the shores, the banks raised and straightened, the bed of the stream narrowed. From one end of the city to the other the river flows between walls of masonry from which quays are built out, narrow in the center of the town, larger in the outlying quarters given over to manufacturing and trade. In early days the shores were almost all sloping, so that rafts and the little craft of those days could be dragged up the banks; these landings were called tow landings. Modern vessels cannot lie against such a sloping bank, and during the last twenty-five years landings that rise perpendicularly from the water level have been gradually substituted for the tow landings. Today merchandise is loaded and unloaded on twenty-nine modern wharves, about 10,756 meters long

in all, with decks varying from ten to seventy meters, and on nine tow landings, 3,690 meters long in all. To these must be added the landing stages, some 5,917 meters long, used only for the unloading of lumber and firewood.

Need of Modern Installations

It is obvious that the port of Paris does not lack wharfage room along the shores of its rambling river, but the commercial use of these waters is interfered with by the fact that there are thirty-three bridges, some of them very low and consequently very dangerous, on account of which navigation

Fig. 4—Fête on the Seine about 1640 (after a print by Callot). Looking down stream: on the right the Old Louvre; on the left the famous Tour de Nesle.

ceases at night. Then, too, there are all manner of floating bathhouses and washhouses encumbering the stream and hampering the movements of vessels. Above all there is not enough room between the wharves and the town for the necessary shops, warehouses, railways, and equipment. Very few great storage buildings are seen along the shores of Paris. The warehouses at the Villette basin, at Ivry, at the Arsenal basin, and at Austerlitz are the exceptions. The fact that there are so many points along the whole water front easily accessible for barges has apparently retarded the adoption of mechanical means of unloading. One may still see this work carried on in many places by hand, men unloading sand with shovels, carrying coal ashore in sacks on their backs, or lugging bags of cement. These scenes appear picturesque to the strolling onlooker but are ridiculous in the extreme from the point of view of modern commerce. There are only a few private landings on the Seine where suitable equipment has been installed, at Gennevilliers for the Suburban Gas Company, at Issy for the Electric Service Company, at Ivry for the Light and Power Company, and at Austerlitz. In the public landings used for general traffic the equipment is wretched, there are few cranes, and labor by hand is slow and costly. Another dis-

advantage is that there is little direct connection between the wharves and the railway lines. These latter cannot be brought down to the water front because of the already enormous congestion of urban surface travel, street cars, omnibuses, carriages, automobiles, and pedestrians. On most of the docks along the Seine cargoes are discharged into horse-drawn drays or motor trucks. There are but few landings where the railroad runs to the river so that merchandise can be transferred directly from ship to car and vice versa. On the Eastern Railroad only Villeneuve-Triage above Paris and La Villette are in direct touch with the shipping; on the Paris-Lyons lines only Bercy, Charenton, and Villeneuve-St. George; on the Western Railroad there are Javel, St. Cloud, and Gennevilliers; on the Orléans railway the ports of St. Bernard, Ivry, and Austerlitz; on the Northern Railroad only St. Ouen. This is due, not alone to material difficulties, but to the systematic hostility of the railroads to any scheme for carrying freight by water.

The port of Paris also suffers from a malady common to all old countries, namely a conflict of authorities, growing out of the constant overlapping of administrative functions in the course of hundreds of years. Regulation of the port falls under three departments: the Department of Bridges and Highways, the Paris Municipality, and the Prefecture of Police. There is no single head, no co-ordination; there is consequently an infinite amount of neglect, indifference, and inadequate regulation. Every user of the public docks is free to bring materials there, to leave his barrows and carts, to pile up his merchandise, in a word to create as much confusion and disorder as he pleases. At Paris, as at London, Antwerp, and Mannheim, there should be a single authority which should have entire control of the use, upkeep, and general management of the port.

Such are the waterways of the port of Paris; let us now see to what uses they are put and what manner of commerce they carry.

The Traffic

Trade in the port of Paris, as the subdivision of the port within the very borders of the city indicates, is closely related to the economic necessities of the town. The port is not a center for foreign trade as are some other river ports of the world that are accessible to seagoing vessels, like Manáos in Brazil, Hankow in China, and Ghent in Belgium. It is not even a focal point for regional trade, the outlet for a large section of back country, as is Mannheim on the Rhine. It is essentially a port for the city of Paris alone; its activities are strictly local and urban. This limited rôle is oddly at variance with the position of Paris itself in the foreign trade of France.

The port, as a component part of the city, has grown with it. Since the beginning of the nineteenth century there has been a constant increase in the amount of incoming freight. In thousands of metric tons (tons of 1,000 kilograms), it was: 1,380 in 1823, 1,418 in 1830, 2,020 in 1840, 2,868 in

FIG. 5

FIG. 6

FIG. 5—The Seine about 1670. View from an old engraving. Looking up stream: on the right Ile St. Louis; on the left the port of Grève, one of the most important ports of old Paris, now the site of the quai Hôtel de Ville.

FIG. 6—The Seine at the end of the seventeenth century. View from an old engraving. Looking up stream towards the pont de la Tournelle: on the right the double arch of St. Bernard, one of the gates of medieval Paris, now no longer standing.

1861, 3,675 in 1869, 4,469 in 1880, 7,567 in 1900, 8,205 in 1910, 11,709 in 1913.

When the improvements along the Seine, the tributary rivers, and the canals augmented the freight-carrying capacity of these waters they became dangerous rivals of the railroads. Whereas in 1860 67 per cent of the merchandise that entered Paris came by rail and only 33 per cent by water, in 1908 the proportion had become 53 per cent by rail to 47 per cent by

FIG. 7—The Seine in 1860 (from a photograph). Looking up stream: on the left the Tuileries (Pavillon de Flore); on the right wharves for the unloading of building stone.

water; and today the traffic is about evenly divided between the two, with a slight tendency in favor of shipping by water. The character of the Parisian trade and the special conditions surrounding it account for the fact that the gain in tonnage for the water routes has not been greater.

CHARACTER OF THE TRAFFIC

The most curious single fact about the commerce of Paris is the disproportion between outgoing and incoming freight. Paris is not a great shipping port like Ruhrort on the Rhine or Duluth on Lake Superior but is essentially a port for incoming trade. The Seine brings to the city merchandise destined for consumption there; the situation is the same today as it has been in years past. In 1860 arrivals represented 76 per cent of all the traffic, in 1913, 73 per cent. But, although the greater part of the commerce

of the port has always consisted of incoming shipments, the kind and nature of the shipments have completely changed in the course of the nineteenth century.

For hundreds of years the Seine, provisioning Paris, brought her principally foodstuffs: cereals and flour, salt, wine, fruit, vegetables, and eggs. Firewood was also brought from the forests of the upper basin by means of great rafts that made their way slowly down to the city. Fleets of small vessels gave the waters about Paris an air of extraordinary animation; many of these never left the port again, for the voyage back was long and expensive, and it was cheaper to demolish them. The banks of the river hummed with life; people from every section of Paris thronged to the market places by the waterside. As the nineteenth century advanced,

TABLE I—COMMERCE OF THE PORT OF PARIS, 1912
(*The figures indicate the percentage of the total commerce*)

PRODUCT	IMPORTS	EXPORTS
Coal	33.0	3.5
Building Materials	42.6	67.0
Fertilizers and Refuse	7.9	18.0
Agricultural Products and Foodstuffs	7.2	3.0
Manufactured Products	3.1	3.0
Metallurgical Products	2.3	4.4
Wood	2.7	1.0
Machinery	1.2	0.1

and as the railroads developed, foodstuffs came no longer by water but by rail. The railroads were far better adapted to the transportation of light and perishable merchandise, the waterways more suited to shipments of heavy and bulky cargoes. The accompanying table (Table I) shows the incoming and outgoing freight for the year 1912.

Of the imports foodstuffs hold but a minor place (7.2 per cent.) and consist of wines from Algeria, Spain, and Bordeaux via Rouen; grain and flour of both domestic and foreign origin; salted meats, sugar, salt, groceries from overseas. It is surprising to see fertilizing materials and refuse arriving in a city (7.9 per cent of the incoming tonnage); but this is explained by the fact that these cargoes are the street sweepings, garbage, etc., of the city that are being sent from one part of the town to another or to the disposal and reduction works in the suburbs at Issy, St. Ouen, Vitry, Stains, and Alfortville.

Coal and building materials form the bulk of the traffic, more than three-quarters of the entire amount received at the port. In a growing city like Paris the erection of new buildings and the construction of various public works necessitate enormous quantities of heavy materials, stone, sand, gravel, cement, lime, plaster. These are brought by the river and unloaded at

the dockyards along its course. Coal is also an essential commodity to a city which is an industrial center, a consumer of light, heat, and power. Two-thirds of all the coal used in Paris is brought from England and northern France by way of the Seine. In fine, Paris receives few foods, few manufactured articles, and even few raw materials.

Comparison of the inward and outward shipments of Paris gives surprising results. Wreckage from the demolition of buildings, framing from construction work (classed as building materials), and refuse make up the greater part of the city's outward-bound shipments, 85 per cent of the whole. Thus the river can well be said, in view of the character of its chief cargoes, to be the means of cleaning, enlarging, and beautifying Paris.

TABLE II—REGIONAL DISTRIBUTION OF THE COMMERCE OF THE PORT OF PARIS, 1912
(*The figures indicate the percentage of the total commerce*)

REGION	SHIPMENTS AT PARIS FOR:	ARRIVALS AT PARIS FROM:	TOTAL
Marne	1.4	6.8	4.1
Yonne, Saône, Rhone	2.0	1.5	1.75
Upper Seine, Loire, Allier	56.0	31.3	43.65
Lower Seine, Rouen, Havre	21.0	30.9	25.95
Oise, Northern Canals	6.0	23.3	14.65
Ourcq	13.6	6.2	9.9

As to the purely commercial traffic, the small amount handled should not surprise us. Paris is indeed a great industrial center, but its output does not consist of ponderous articles but rather of delicate things, objects of luxury, merchandise of great value but small volume, which would naturally be sent by rail. A few fast packets only carry down to Rouen and Havre articles from Paris bound overseas.

The port of Paris is therefore seen to be not so much a means of commercial relations with the outside world as an important factor in the life of the city, carrying its heavy domestic cargoes.

DIRECTION OF THE TRAFFIC: ORIGINS AND DESTINATIONS

Great changes have taken place in the direction of the traffic on the Seine in the course of the nineteenth century as well as in its character; in particular it shows a shift from the east to the north and the west.

As long as the Seine played so great a part in the provisioning of Paris the port's chief relations were with the upper basin. From up the river came grain and wood; from the Marne region came grain, flour, wine, iron, and wood; from the Yonne, wood, wine, bricks, and oil; from the Loing, coal; from the central region, fruits, wine, wood, metals, and tiles. From the lower Seine came some colonial shipments by way of Havre. The Oise region hardly counted at all.

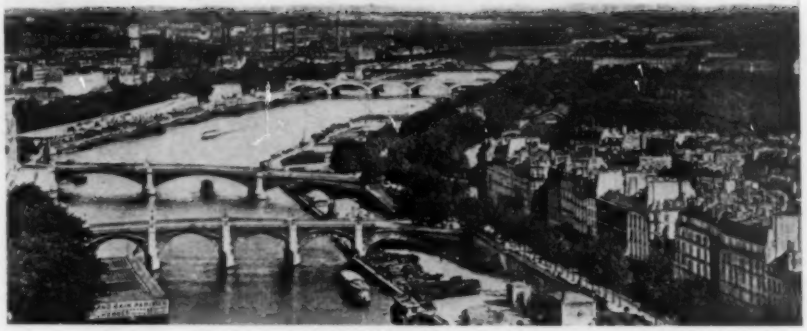

FIG. 8

FIG. 9

FIG. 10

FIG. 8—View of the Seine looking up stream from Notre Dame: on the right the quai St. Bernard (wine). Compare with Fig. 5.

FIG. 9—The Villette basin at the junction of the Ourcq, St. Denis, and St. Martin canals: a busy industrial section.

Fig. 10—On the canal St. Martin.

When the railroads had taken over the expediting of foodstuffs, and coal had become a necessity of everyday life, the course of traffic altered in favor of the lower Seine and its tributaries by which came the latter commodity. Table II shows the origin and destination of Paris consignments for the year 1912.

Table II calls for some comment. The commercial tributaries of the port of Paris should be divided into two groups: those upstream (Marne, Yonne, upper Seine), which supply 49 per cent of the total traffic (39.6 per cent of the arrivals and 59.4 per cent of the shipments); and those downstream (lower Seine and Oise), which are responsible for 40.6 per cent of the total traffic (54.2 per cent of the arrivals and 27 per cent of the shipments).[2]

The upstream tributaries of the port of Paris are the upper Seine, connected with the Loire by the canals of Loing and Briare; the Yonne, connected with the Saône by the canal of Bourgogne; and the Marne, connected with the Meuse, Moselle, and Rhine by the Rhine-Marne Canal. Their commercial importance does not correspond with their position on the statistical table, for more than 75 per cent of their traffic is limited to the part of the Seine lying between Paris and Montereau. Materials shipped along this section are chiefly building materials from the quarries sent down to Paris, and refuse from Paris carried up the river and dumped into the excavations made by the quarries. If to these are added similar cargoes on the Marne and Yonne, together with the refuse carried by all these rivers, the resulting figures give 90 per cent of all the heavy shipment. The remaining 10 per cent includes wood from Champagne, Bourgogne, and Lorraine, the products of the smelters and ore mines of Lorraine, German coal, wines and foodstuffs coming from the east and center—all consigned to Paris. Shipments out of Paris in this direction are so few as to be negligible.

The downstream tributaries of the port of Paris are of much greater importance. The lower Seine receives all export and import trade by way of Havre and Rouen. The upper waters of the Oise are in touch with the coal-mining regions of northern France and Belgium; the river empties into the Seine at Conflans, 72 kilometers below Paris. By these two waterways alone Paris received, in 1912, 2,259,423 tons of coal coming from the northern districts and 1,294,455 coming from England—a total of 3,553,878 tons. Coal constitutes three-fifths of all products received from downstream. The Oise is the special route for coal from the north. Besides the coal, the river carries only 150,000 tons of building materials, 20,000 tons of wood, 30,000 tons of castings and iron ore, and 70,000 tons of sugar and molasses.

The value of the lower Seine as a commercial trade route is greater still. First and foremost it is 3.2 meters deep—deeper than any other waterway of the basin—and can accommodate vessels of much greater draft; next it reaches ocean trade through Rouen and Havre. To Havre comes merchan-

[2] Not including the Ourcq, which brings to Paris building materials and wood from a small region to the north of Paris but whose upper end has no outlet. This stream is really part of the port of Paris.

dise brought by ships from overseas, to Rouen heavier cargoes brought by the international coasting trade. Rouen, really the outport of Paris, is the point where transshipments of cargoes are made. It may be said that during the war Rouen saved France, for located far from the battle line it was able to send up to the factories of Paris the coal that France so badly needed. In 1917, 6,206,000 tons of freight, of which 4,568,000 were coal, went up the Seine from Rouen to Paris.

Conclusion

The entire character of the port of Paris makes it a local port, chiefly used by and for the great city. The enormous proportion of the incoming

Fig. 11—Ile de la Cité, site of the first foundation of Paris.

freight is made necessary by the diverse requirements of the huge urban agglomeration that consumes large amounts of heavy merchandise but produces almost none.

But must this port always be confined to local uses? Can it not enlarge its commercial scope? Why should not Paris become a forwarding port? Why should not certain kinds of merchandise be shipped to Paris to be sent further on, rail freight transferred to the water, water freight to the railroads there? This idea of further developing its commercial usefulness is not a vain dream. Paris, purchasing many products in tremendous quantities, establishes a market for those products within her borders. She receives more than she herself requires and can reship and resell. There are already some goods that Paris re-exports, often to great distances; wine from the warehouses at Bercy, sugar, wood, coffee, charcoal, grain, some few articles made of iron, tools, and machinery. When the day comes when cold

storage meats can be brought up from the maritime ports by river boats the meat markets of La Villette can widen their range of distribution.

This idea of making Paris a great transshipping port whose power and influence would be felt even abroad was talked of in earlier days. In 1832 a law authorized the erection of bonded warehouses in the interior of France. Merchandise was to be received there in bond, duty to be paid only if the goods were sold in France. If they were sent out of the country again they went out free. At Paris, on the banks of the St. Martin Canal the Marais Warehouse was built, where copper, coffee, cocoa, pepper, lead, precious woods, sugar, and gums were stored. The idea was principally to make Paris the port of shipment between the ocean and the Rhine countries.

Such a scheme, however, cannot be carried out by money alone. The enormous sums at the disposal of the Parisian trade are not enough in themselves to set up trade currents. Swift, powerful means of transportation are necessary to attract trade in transit. Merchandise now going to the Rhine countries has at its disposal means of transportation with which the Seine cannot compete, the Scheldt to Antwerp, the Rhine to Mannheim, Strasbourg, and even to Basel. In order to become an important port for transshipping and re-forwarding, Paris needs to become a deep-water port, where the railroads and river craft can be brought directly in contact with ocean-going ships. It should become the terminal for the one kind of shipment and the starting point of the other.

The dream of a port of Paris with an anchorage depth of 6 or 7 meters seems abandoned. But a more modest scheme for a depth of 4.5 meters would give considerable chance for hastening this desired improvement in commercial relations. Many things could be brought to Paris directly, both by coasting vessels and ocean-going craft—English coal, American grain, oil from the United States, wood and paper pulp from Scandinavia and Canada. The ships arriving laden at Paris would take on a return freight of chemical products from the east and of iron ores from the Lorraine basin. The profitable exchange between coal and iron cargoes that has made fortunes for shipping in other parts of the world, on the Great Lakes in the United States, on the German and Dutch Rhine, and the British coast for example, would be made possible for French shipping. Eastern France would have a new outlet to the sea through French territory; the influence of Paris would be felt throughout Central Europe, and France would be able to avail herself to the utmost of her splendid geographical position which makes her a passageway between maritime Europe and the interior regions.

ON ESKIMO STONE ROWS IN GREENLAND FORMERLY SUPPOSED TO BE OF NORSE ORIGIN

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In the following article will be described certain stone rows occurring in Greenland. They were once considered to be remains of structures built by Norsemen in ancient times, but they are without doubt of Eskimo origin. Inasmuch as one kind of such rows, the *nangissats*, have not hitherto been found outside of Greenland, it appears worth while to call them to the attention of American ethnologists and geographers. The other kind, fences used in deer hunting, are probably very common in Arctic America but are extremely rare in Greenland.

Nangissats

Previous Mention in Literature

In Kleinschmidt's dictionary of the Greenland dialect of the Eskimo language (1871) we find:

> *nängivoq*, he hops (i. e. makes a single leap on one leg).
> *nängissarpoq*, he is hopping (iteratively).
> *nängissat*, big stones, found in various places lying on level ground with considerable intermediate space. They are ascribed by tradition to the old Icelanders, who are said to have placed them for leaping on them on one leg right through the whole row.[1]

In the dictionary of O. Fabricius (1804) we find only the word *naingirsarpok*, "he hops on one leg." As far as I am aware the word *nangissat* is mentioned for the first time by C. L. Giesecke in his "Bericht einer mineralogischen Reise in Grönland (1806–13)." As this work was not published till 1878 (2nd edit., 1910), Giesecke's remarks could not have been known to Kleinschmidt, who lived and worked in Greenland and had no access to libraries or archives. The passage by Giesecke follows.

> Diese Stelle, von den Dänen *Halteplads* oder Hinkstelle genannt, hat ihren Grönländischen Namen, Naingirsaet, von einem ehemals sehr gebräuchlichen Nationalspiele erhalten. Die Spielenden mussten nemlich in gerader Linie nach einem Ziele, welches mit einem Steine bezeichnet wurde, auf einem Beine hüpfen oder hinken. Welcher nun am besten oder weitesten hüpfen oder hinken konnte, gewann den Preis. Man sieht noch auf dem Plazze lange Reihen solcher angelegten Steine. Sodann versuchten sie ihre Stärke im Häckeln oder Finger- und Armziehen, auch im Ringen, worauf das Schlagen mit der flachen Hand

[1] Samuel Kleinschmidt: Den grönlandske Ordbog. Copenhagen, 1871, p. 234. All Danish quotations in this article are in translation.

FIG. 1—The *nangissat* in Disko Fiord, Disko Island (lat. 69° 27′ N.; long. 53° 41′ W.). The stones are laid out on a sandy neck of land behind a low gneissic headland. (Photograph by K. J. V. Steenstrup.)

auf die aufgeblasenen Wangen folgte. Hierauf wurde Wettrennen zu Wasser mit Kajaks und Umiaks gehalten, wobei manches der letztgenannten Fahrzeuge, wenn man nach dem Strande zurannte, in Trümmer gieng. Der Beschluss wurde gewöhnlich mit Balliarspiel und Streitgesängen gemacht. Noch vor 10–15 Jahren übten sie sich im Nördlichen Grönland in dergleichen Spielen, welche nun nach und nach aus der Mode kommen, und dem verderblichen Kartenspiele Platz machen.[2]

The place mentioned by Giesecke is, like several others, still called Nangissat and is still normally inhabited. It is situated on a small sandy neck of land behind a protruding rocky naze on the northern coast of the southern branch of Disko Fiord on Disko Island. The place was also described later by Steenstrup[3] who thus expresses his opinion on the origin of the *nangissats*:

There thus exists no evidence of those stone rows being known to other Eskimo tribes or to the ancient Icelanders. But as the *nangissats* do occur in the northern parts of West Greenland, where the ancient Icelanders never settled, and as there is no reason for assuming that they have been constructed during their transitory summer visits, it seems most probable that the *nangissats* originate from a specific Greenlandic game now forgotten. It is not credible that this game was in use up to Giesecke's time, as it then, without doubt, would have been mentioned in the earlier literature.[4]

With these quotations the references to *nangissats* seem to be exhausted, with the exception of the doubtful cases mentioned below.

Description of Some "Nangissats"

The *nangissats* seen by the author of this article are all situated on somewhat elevated, nearly level ground in the neighborhood of settlements or summer camp sites. The places are generally quite exposed to the prevailing wind, and consequently the ground is bare of vegetation in summer and of snow in winter, being covered with coarse sand or gravel (see Figs. 1 and 2).

Most frequently the stones are placed in a single straight line. They are usually about as large as could be lifted by a strong man, and their weight alone is sufficient to keep them in place when hopped on. But often for lack of stones of suitable size smaller ones have been used. Their upper surfaces are comparatively smooth. The distance between the stones does not vary much, being ordinarily little more than half a meter. I could easily hop from one stone to another, but I always found it wearisome to hop over a large number. I have counted as many as 70 stones in a single row.

[2] C. L. Giesecke: Bericht einer mineralogischen Reise in Grønland (1806–13). Copenhagen, 1878. 2nd and complete edit. in *Meddelelser om Grønland*, Vol. 35, 1910, pp. 1–478; reference on p. 460.

[3] K. J. V. Steenstrup: Beretning om en Undersøgelsesrejse til Øen Disko i Sommeren 1898, *Meddelelser om Grønland*, Vol. 24, 1901, pp. 249–306. Steenstrup quotes the above given passage by Kleinschmidt, briefly refers to Giesecke's opinions, and remarks that neither the word *nangissat* nor the game for which the stone rows were intended has been mentioned by Hans Egede or his sons, nor by D. Cranz. He also states that nothing corresponding from East Greenland is known to Mr. G. Holm and that neither Mr. G. Holm nor Mrs. Signe Rink knows the word or the game from the Eskimo tales familiar to them. On the other hand the *nangissat* is quite unknown in Iceland either from present day evidence or from the ancient literature.

[4] *Ibid.*, p. 293.

Sometimes the conditions of the ground were not suitable for one long row, and the *nangissats* have then been laid out in other forms. I have seen rows forming two or three sides of a rectangle. In one case (Nivâq Bay) the row terminated in a sickle-shaped hook. Another (which I have not seen) is reported to have the form of a cross (Fig. 4). According to my informants the last-mentioned was subsequently rebuilt "because it was too difficult," i. e. the original distances between the stones were too great. At Igdlutalik there were two rather short *nangissats* of big stones for "grown-ups," as I believe, and a third one of smaller stones and with shorter distances, for children.

Use of the "Nangissats"

Nowadays the game of hopping on stone rows is never played either by children or by adults. When accompanying travelers, however, our Greenlanders will, just for fun, hop over some of the stones, so as to demonstrate a knowledge of their meaning. In old times, however, the game belonged to the rather large number of sports and contests engaged in either as a pastime among the villagers, or as challenges to strangers, or during the annual feasts when controversies were settled by juridical drum songs.

Local tradition exactly agrees with the description given by Giesecke in the above-quoted passage, although the game was not played at all in his day. My informants relate that the player also had to carry a weight in his arms, such as a bundle of sealskins, the dead body of a small seal, or a live dog.

The Distribution of "Nangissats" in West Greenland

Between the 67th and the 72nd parallels of West Greenland *nangissats* are quite common. Indeed, I am inclined to believe that here every larger settlement or camp site from ancient times may have had its own *nangissat*. The accompanying map shows the location of those known to me personally or by reliable verbal or written reports. I have not heard of the existence of *nangissats* north of the 72nd parallel, and from two places, Ikerasaq (72° 13′ N., 55° 7′ W.) and Söndre Upernavik (72° 9′ N., 55° 53′ W.), I have had direct information of their absence. From South Greenland, south of the 67th parallel, *nangissats* have never been reported by any of the numerous Danish traveling scientists or resident officials. In Unartoq Fiord, however, near the colony of Julianehaab, Giesecke has seen "ein von den alten Normännern aus Steinen in die Erde eingelegtes Kreuz."[5] From this very brief description it is not clear whether the cross lies near ancient ruins of Eskimo or of Norse origin, or whether the situation of the stones, their sizes, and the distances between them would permit the use of the cross as a *nangissat* or not. But, as cruciform *nangissats* do occur elsewhere I prefer to consider the above-mentioned stone cross as a *nangissat*, at least until further investigation proves the contrary.

[5] Giesecke, *op. cit.*, p. 210.

FIG. 2

FIG. 3

FIG. 2—Another view of the *nangissat* shown in Figure 1. (Photograph by Morten P. Porsild.)

FIG. 3—Two of the *nangissats* on the islet of Igdlutalik (lat. 69° 53′ N.; long. 50° 33′ W.). The one is of big stones for use by adults, the other of smaller stones for use by children. Eskimo graves are seen at the end of the stone rows. In the background is part of Atâ basin filled with calving ice from the Torssukátak ice fiord. (Photograph by Morten P. Porsild.)

It is possible that a more careful investigation of other parts of Greenland would reveal a wider distribution of *nangissats*. If, on the other hand, they should prove to be restricted to the regions about Disko Bay and Northeast Bay, this fact in itself is sufficient to account for their omission by the

FIG. 4—Map showing distribution of *nangissats* in West Greenland constructed from data supplied by the author. The locations of all *nangissats* known to the author are here shown with the exception of that on the southern coast of Sarqardlit Island.

earliest writers—the Egedes, father and son, Cranz, Dalager, Glahn, etc.—as they all lived in South Greenland, and their knowledge and experience were confined to that part of the country.

Kleinschmidt too lived in the southern part of Greenland. If he had lived about Disko Bay or gathered his information from people there, he surely would never have assumed a Norse origin for the *nangissats*. Their

occurrence at the ancient settlements of pure Eskimo origin is sufficiently decisive even if one might be inclined to discredit, to a certain degree, the traditions of the Greenlanders. Nevertheless it is rather remarkable that the game of *nangissat* was not mentioned in the West Greenland tales, at least as far as we know them in the collections edited by Rink. Yet in this matter further information may be expected as the stock of West Greenland tales is by no means exhausted.

FIG. 5—Part of the cruciform *nangissat* at Ikorfat, on the northern side of the Nugssuaq peninsula. (Photograph by Mr. J. P. Ravn.)

ARE "NANGISSATS" A PROVINCIALISM IN ESKIMO CULTURE?

Nearly every article on Eskimo culture ends with a strong emphasis on its remarkable unity—on the similarity of language, tales, traditions, religion, folklore, as well as of tools and hunting implements and methods among a widespread people. Numerous features at first believed to be peculiarities or provincialisms confined to a restricted area have by closer investigation proved to have a far wider range. This may prove to be the case in the present matter. If, on the other hand, future investigation should fail to find *nangissats* outside of Greenland, we should be forced to regard them as a true provincialism. A recognized provincialism in the culture of

the Greenland Eskimos is the occurrence of the so-called feathered harpoon shaft, the *ernangnaq*, together with the common form, the *unâq*, also known elsewhere. At the present time the two forms of shafts have by intercourse become scattered all over the coasts of Greenland; but probably they were invented at different times by different and detached bands of immigrants to Greenland, who had to reconstruct their kayaks and implements for their use, after the long wanderings through icebound regions where kayaks could not be used[6]. The sport of hopping on stone rows may perhaps have originated somewhere near Disko Bay and spread from there northward and southward, later to go out of fashion.

Saputit

Previous Records

The Greenland Eskimo word *saputit* is derived from the verb *sapivâ*, "he confines it," and signifies "means for confining," or, generally, "a fence," "a hedge." Ordinarily the word is used for a dam or a fence of stones across the mouth of a trout river.

However, on the southern coast of Nugssuaq Peninsula, near the settlement of Akúnaq (69° 52′ N., 51° 30′ W.), a fence is found of an extraordinary size. Therefore the word *saputit* has come to signify the whole region around the spot. When, in 1915, the Danish historian Dr. Louis Bobé went to Greenland to investigate the remains of early Danish colonization, the natives guided him to Saputit, with the suggestion that the stone fence there might originally have been a sort of defensive structure erected in ancient times when hostilities were supposedly carried on between the Eskimos and Norsemen or Dutch or British whalers. Having investigated the fence, Dr. Bobé called my attention to the place, which was previously unknown to me, and put his notes and sketches in my hands. On my return from a trip to the vicinity during the fall of 1915, I paid a short visit to Saputit. Unfortunately I had then used all my films and therefore was not able to take a photograph of the fence.

The place has been mentioned in literature also by Giesecke: "Wir sezzten über die Bucht Saputit, so genannt von den kleinen Steindämmen, welche man hier beym Bergstrome des Lachsfanges wegen legt."[7] This remark of Giesecke shows that he knew the general meaning of the word, but it also implies that he did not land there or see the fence in question at all, as will readily appear from the description of it given below.

Description of the Locality

The bay at Saputit (Fig. 5) is not shown on any of the existing maps. It is rather spacious, extending from the coast line northward and continued

[6] M. P. Porsild: Studies on the Material Culture of the Eskimo in West Greenland (Arbejder fra den Danske Arktiske Station paa Disko, No. 7), *Meddelelser om Grønland*, Vol. 51, 1915, pp. 111–250; reference on p. 121.

[7] Giesecke, *op. cit.*, p. 359.

inward by two valleys, divided by a high and steep hill, Ingigsoq. The eastern side of the bay is formed by a somewhat steep rocky hill whose name, Orpigarssuit, Dr. Bobé made note of. This name, meaning "the remarkable big thickets," cannot belong to the cliff, as any growth of willow thickets is impossible there, and so probably refers to the lowland lying north of the cliff. The western side is a low foreland covered with vegetation, about one kilometer broad, ending abruptly on the west at the steep side of another cliff. For this cliff Dr. Bobé has recorded the name Palutugataq. In this form the word has no meaning; probably it is derived from *patdlugut*, "the handle of the Eskimo's adze," or from the verb *patdlungavoq*, "he lies on his belly with raised head." Without doubt the name refers to some

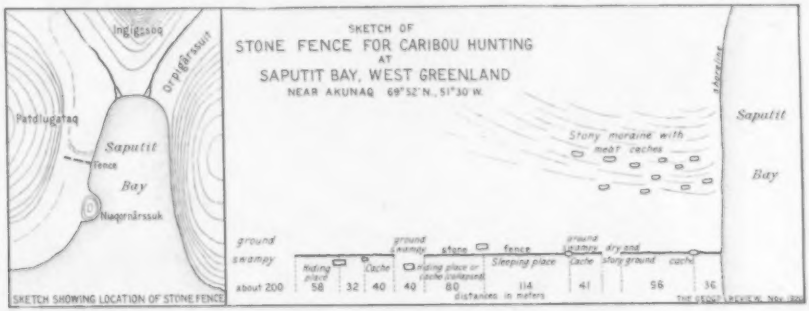

FIG. 6—Sketch of fence for caribou hunting at Saputit Bay. (After a drawing by the author. The spelling of place names follows that of the original sketch.)

contour of the rocks. At the shore of that foreland is a small rocky head protruding into the bay, called Niaqornarsuk. Somewhat inside Niaqornarsuk the fence extends in a nearly straight line from the shore across the foreland towards the foot of Palutugataq.

DESCRIPTION OF THE FENCE

The fence was made of both large and small stones. Numerous large rocks, either stationary or too large to carry, are built into the fence, slightly modifying its straightness. All the stones are of a rather schistose gneiss, mostly flat in form. As far as possible they are set on edge; and it is very plain that the builders did not aim to construct a solid fortification, but only something that should serve as a place of concealment. Sods have never been placed between the stones, and consequently numerous interstices are to be found. Even the strongest man could hardly have managed by himself to carry the biggest transported stones; they must have been rolled into position. A few meters inside the fence a terminal moraine stretches across the foreland. At some earlier time the finer materials of the moraine were washed out by the sea, the stones being left. The fence builders purposely chose the border of that stone heap as the place for their work;

here the suitable stones in the immediate vicinity are exhausted, but a little farther within the fence there is still a wealth of loose stones.

In the main the fence is quite undisturbed, standing as it was at the time of its construction. In some places, however, the stones were rather small, and there the fence has partly collapsed. Its average height is one meter, but no absolutely uniform height was intended. The fence follows the roughness of the ground, the highest point of it lying some 20 meters above high-water mark. At present the shore here, as elsewhere in West Greenland, is rapidly sinking.

Along the fence, or sometimes into it, numerous square hiding places or sleeping shelters of stones raised on edge have been built. In addition there also occur several caches of solidly and closely laid stones. In the fence itself there are some gaps or interstices where no stones have ever been set. Near the shore are numerous caches on both sides of the fence, and still more on the stony moraine. Along the shore outward are numerous sleeping places and tent rings; also an old path may be discerned, and at Niaqornarsuk camp sites of modern origin are to be seen. Details of the fence, which runs from a point about 200 meters eastward from the steep western cliff to the shore line, are given in the accompanying diagram.

FIG. 7—The seaward end of the fence shown in Fig. 6. (Drawn by Miss Ingeborg Hydahl after a sketch by Dr. Louis Bobé.)

THE PURPOSE OF THE FENCE

There is no doubt, the size, form, and environment being considered, that the fence was intended for caribou hunting, like similar fences in Greenland and elsewhere. The caribou were driven through the two valleys towards the head of the bay, and here they followed the foreland on the western side to the fence behind which were concealed the hunters with their bows and arrows. In spite of the weakness of its construction, the caribou were not able to leap over the fence but were forced through the gaps where they were shot or whence they took to the water where their lancing from kayaks was easy.

At the ice fiord of Jakobshavn, which lies about one degree of latitude to the south, traditions exist among the present population of their ancestors hunting caribou in the environs of Saputit. Before the Danish colonization perhaps the largest settlement known in Greenland was at Sermermiut close to the ice fiord.

Age of the Fence

Ordinarily in Greenland every exposed stone surface is covered with a dense growth of black lichens. Apparently the stones of the fence have been placed so that their black sides faced inland, the bare ones facing the sea. At the present time lichens have partly crept around to the side originally bare. But the growth of the black lichen crusts is extremely slow in Arctic regions. An example will better illustrate this fact than many words. In the last century Giesecke wrote his initials on a stone on a mountain top in South Greenland simply by scratching off the black lichen growth with his knife. Some seventy years later K. J. V. Steenstrup found the stone, and the scratching seemed to him as fresh as if it had been made but a few days before! From the appearance of the lichen growth alone on the stones at Saputit we may infer a high age for the structure—at least several hundred years. This conclusion is borne out also by the growth of the mosses and grass at the foot of the fence stones, especially on somewhat swampy ground where the snow is late in disappearing. Here the lowest stones were overgrown, often to their very tops.

The fact that the present population seems to have quite forgotten the former use of the fence also proves the work to be of considerable age. The story that it was a defensive construction against Norsemen, Dutch, or other invaders is, for technical reasons alone, quite absurd. Surely this idea must have originated in the brain of some European who had heard descriptions of the fence by the Eskimos without having seen it with his own eyes. Afterwards the explanation was apparently adopted by the Eskimos themselves with their customary politeness. In a quite analogous way the story of the existence of a sound across Greenland in the latitude of the ice fiord of Jakobshavn was originally derived from misapprehensions by the ancient writers, told by the first settlers to the natives, and politely adopted by them.

Rarity of Fences for Hunting in Greenland

Whilst hunting fences are quite common in the caribou districts of Arctic America, their occurrence in Greenland seems to be remarkably rare. From the literature of the subject I only know of the following cases.

On the large river at the head of the branch of Ilua Fiord known as Kangikitsoq (near Cape Farewell) between four small hills there is to be found a large arched stone fence; and in the vicinity of it are two square much dilapidated ruins. They were discovered and described in 1778 by A. Arctander and were supposed by him[8] to be of Norse origin, intended for fencing cattle or sheep, although the square house-like ruins were in such a state that nothing certain could be determined about them. But when

[8] A. Arctander: Udskrivt af en Dagbog, holden i Grønland paa en Recognoscerings Reise i Julianæhaabs District i Aarene 1777–1779. Published by H. P. von Eggers in Samleren, Vol. 6, Copenhagen, 1793. Arctander's description is repeated in the classical handbook of Norse remains in Greenland, "Grønlands historiske Mindesmaerker," 3 vols., Copenhagen, 1838–45; reference in Vol. 3, p. 800.

G. F. Holm investigated and mapped the country here, in 1880, his accompanying Greenlanders declared to him that the fence was intended for caribou hunting and the ruins were those of Eskimo houses.[9]

Another fence, also in arched form, was discovered and described in 1834 by Jacob Arøe. A part of his diary for the trading post of Nanortalik is a description of a trip made in the fiord of Tasermiut in South Greenland for topographic and antiquarian researches. This part has recently been published by H. Ostermann. We read here:

> At the head of the bay [Tasiusaq on the eastern coast of the fiord] *rudera* occur a little above the lake on a low hill, but they are very inconsiderable and quite collapsed, so that it was impossible to form any opinion as to their true character; they were, however, of small size and could hardly have formed more than two houses. In this locality, near the house ruins, was further observed a fence of rather large stones, forming a semicircle down to the shore, about 50 paces long. The proper purpose of this fence was not clear as on the middle of the hill it touched a large rock and did not seem to have formed any inclosure. Small stone walls were also seen on the hill, built close to large rocks, thus forming square spaces of a size of 1 or 2 ells, sometimes with the one side left open, but very insignificant and only one stone high above the ground.[10]

Although the fence here is rather short, there can hardly be any doubt of its having been intended for caribou hunting. The small inclosures behind the large rocks are hiding places or caches.

Finally, we have a case from East Greenland, namely on the island of Kulusuk near Cape Dan, in Angmagssalik Fiord. W. Thalbitzer gives an illustration of it and writes:

> At the one end of a fertile plain, which reaches down to a large inland lake, there is a narrow strait or pass between hills, where we find the remains of the *taalin*, a wall or fence of upraised stones connected with a shooting cover, for use in caribou hunting. The word is the same for the place on Kulusuk and is found as a place name at several localities in West Greenland (here called *talut*), where similar walls occur. In the middle of the wall I have seen there is an opening like a gate, through which the hunted animals have been obliged to take flight. Before the end of the wall are the remains of a rectangular cover in which the waiting hunter lay concealed. I was shown how the animals usually came, from the high slopes in the east, on the way down to the grassy heath and the inland lake. A large detached rock lies out on the heath and behind this a man on the watch conceals himself and signals to the archer in the shooting cover, when he sees the animals approaching.[11]

It may be remarked that the word *talut* in West Greenland really signifies the small square hiding places and not the fences. Hiding and sleeping places without fences are very abundant on all present and former caribou hunting grounds. Of fences for driving the caribou we thus know only four cases altogether.

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[9] G. F. Holm: Beskrivelse af Ruiner i Julianehaabs Distrikt, *Meddelelser om Grønland*, Vol. 6, 1883, pp. 57–145; reference on p. 137.

[10] H. Ostermann: Arkæologisk-topografisk Beskrivelse af Tasermiut-Fjorden in Sydgrønland, forfattet af Assistent Jacob Arøe, *Geografisk Tidskrift*, Copenhagen, Vol. 24, 1917, pp. 75–80; reference on p. 76.

[11] William Thalbitzer: The Ammassalik Eskimo, *Meddelelser om Grønland*, Vol. 39, 1914, pp. 1–755; reference on p. 405.

Scarecrows for Deer Hunting

Hans Egede makes mention of white poles with pieces of sod placed on their tops and planted in rows used as scarecrows by the Eskimos in driving the caribou to the concealed hunters.[12] The hunting is also illustrated in the plate accompanying the description. In the northern parts of the country suitable wood was very scarce, and therefore cairns were used for that purpose. According to verbal information given to me by Mr. E. Anbersen, chief factor of the colony of Upernavik, rows of cairns with hiding places behind them are to be seen on the plateau between the heads of the Umiarfik and Amitsuarsuk Fiords (about 72° 20′ N.). Between these cairns the intervals were from 20 to 30 meters.

[12] Hans Egede: Det gamle Grønlands nye Perlustration, etc. Copenhagen, 1729 and 1741. English transl., London, 1745 and 1818.

AIRPLANES AND GEOGRAPHY*

By Willis T. Lee
United States Geological Survey

The airplane opens a new world to the geographer, for some parts of the earth's surface can be conveniently observed and adequately illustrated in no other way than from the air. Aerial photography is therefore a new and powerful aid in the study of physical geography.[1] It is well known that aerial photography was used in many ways during the World War. A vast fund of information accumulated then is now available for use in various ways.[2] Aerial photography is obviously of particular value in the exploration and representation of areas that are inaccessible or accessible only with difficulty by ordinary methods, such as some parts of the Coastal Plain of Virginia, Maryland, and Delaware.

General View of the Geography of the Coastal Plain

For the purpose of testing the utility of the airplane for observing country of this character a flight of 200 miles or more was made over parts of eastern Virginia. From Langley Field we rose to an altitude of 3,000 feet, then flew southward over Hampton Roads, Norfolk, and the Dismal Swamp. At Lake Drummond we turned northwestward, passing over Suffolk to James River, which we followed upstream to its great meanders. There we turned northeastward, passing over West Point to the mouth of Rappahannock River, and then followed the shore of Chesapeake Bay southward to Langley Field.

The general impression gained from this flight was much the same as that gained by looking down on a map spread on a table. There was no difficulty in recognizing the objects mapped, such as villages, streams, and roads. Even details like the color of the soil appeared startlingly clear, and it was easy to distinguish the well-cultivated from the weedy fields. Town houses and streets appeared as if laid off by a draftsman's rule. The great compli-

*This paper is published by permission of the Director of the United States Geological Survey. It is based on observations made possible by the co-operation of officials of the air services of the War and Navy departments. The assistance of Captain Walter R. Lawson, operations officer, and Captain Fred Place, director of the School of Aerial Photography, at Langley Field, is gratefully acknowledged. These officers placed at my disposal their entire collection of photographs, from which many were selected for illustration, both in this paper and in the forthcoming geographic handbook to be published by the United States Geological Survey. Some of the photographs used here were made by Captain Place for this particular purpose. Captain Lawson also interested himself in the investigation and personally piloted me in flights in order to point out particularly good examples of submerged land forms which he had observed. Later, officials of the Navy Air Service at Washington, D. C., extended similar privileges, and I was able to obtain views of the underwater channels and drowned terraces of the Potomac.

[1] The development of aerial photography has been admirably summed up by Herbert E. Ives: Airplane Photography, J. B. Lippincott Co., Philadelphia, 1920.

[2] Compare E. Lester Jones: The Aeroplane in Surveying and Mapping, *Flying*, June, 1919, pp. 438–441, 472.

cated framework of steel beams at the Newport News shipyards looked like filigree, but the thousands of men at work could not be seen. Many ocean-going vessels lay at anchor in Hampton Roads, but from our lofty point of view they seemed to be as small as rowboats.

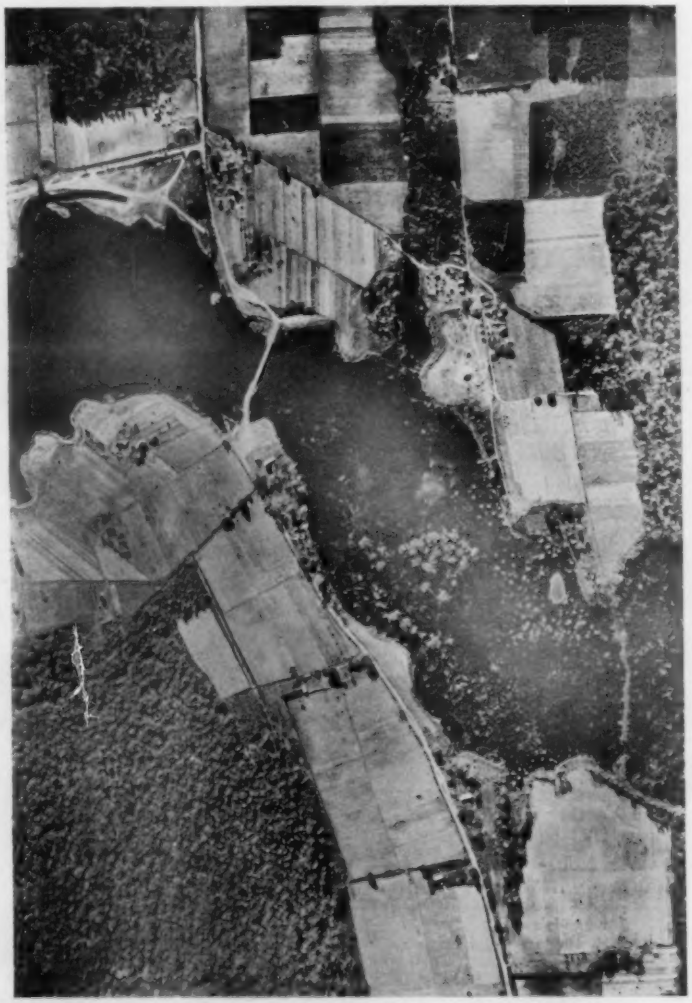

FIG. 1—Vertical view of Big Bethel Reservoir near Langley Field, Va., showing roads, bypaths, and buildings; water in which drowned trees are still standing; cultivated lands (the light-colored plats having parallel ridges); forests and brush-covered lands. (Photograph by U. S. Army Air Service.)

The smoke from Norfolk obscured our vision somewhat while we were over that city, but with our rate of 100 miles an hour we soon emerged from

it to find ourselves over Dismal Swamp, which had the appearance of a vast dark-colored monotonous plain. Lake Drummond, the central body of water in this swamp, had the general aspect of a great hole in the plain rather than that of a body of water. Although the water of the lake is dark brown, like the water of the southern swamps generally, the lake bottom was dimly visible. It differed but little in color from the surrounding forest-covered land except that it was mottled with light areas of irregular shape. The

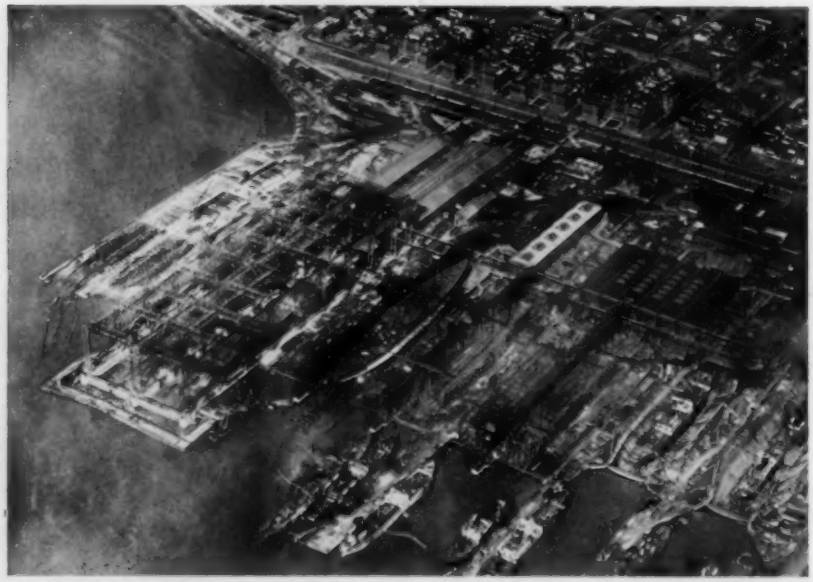

FIG. 2—Newport News, Va., showing city blocks and shipyards with partly completed vessels on ways, in dry dock, and at wharf. (Photograph by U. S. Army Air Service.)

general appearance of the lake basin reminded me of the photographs of lunar craters. The Nansemond scarp where the forested swamp gives place to the tilled fields of the higher lands to the west was clearly recognized. Still farther west the country consists chiefly of wooded valleys, "pocosons," and forested plain with here and there a clearing. Near the main streams, however, the flat lowlands are generally cleared and cultivated.

RESULTS OF TRIAL FLIGHT

So much was gained from this trial flight and so vast seemed the possibilities of obtaining, by means of the airplane, new information on the physical geography of the low-lying areas of the Coastal Plain that other flights were made, some for observation and others for obtaining photographs. Some of these flights were made over land, others over water, and still others over such strange middle ground between land and water as the

tidal marshes, mud flats (see Fig. 6), and drowned lowlands. Some of the more significant observations relating to these flights and to the uses of aerial photography are here recorded. They may be grouped under the following headings:

1. Observations in well-known areas, such as a city, in which there are many details to be shown.

2. Observations in areas such as a marsh, in which many of the details may be unimportant and are usually omitted from maps and descriptions, because the difficulty of obtaining them by ordinary methods is too great to warrant the necessary expenditure of time and money.

3. Observations in submerged areas, where information as to the underwater surface has been obtained heretofore chiefly by soundings.

Determination of Details in Well-Known Areas

It is not the function of this paper to discuss the application of aerial photography to the making of maps, except in so far as maps are incidental to geographic study. But the interests of the map maker and the student of geography are so nearly identical that it is difficult to omit all references to mapping. In fact, the country as seen from a plane high in the air has a striking resemblance to a map. For this reason aerial photographs properly taken and properly interpreted make excellent maps. But just as the reader of a map must know the meaning of the symbols used on the map, so the user of aerial photographs must learn to interpret them. For example, when a photographic print is so oriented that shadows point toward the observer, hollows and hills, buildings and trees appear natural. If the print is reversed, hills may have the appearance of hollows. By practice the observer soon learns distinctive characteristics. Forests are readily distinguished from brush lands, and even the kinds of trees may be recognized by their characteristics of growth. Orchards may be recognized by the even spacing of the trees. Paved roads may be distinguished from secondary roads and byways. Bridges, fords, and a great variety of small objects may be recognized by some distinctive peculiarity.

It is well known that the accurate mapping of a tract which contains many details that are to be shown is very expensive. The cost of really accurate representation on a map of all buildings, streets, and alleys of a city, such as Newport News (see Fig. 2), is almost prohibitive. It is certain that aerial photographs properly oriented by means of points in the photographed area whose locations are accurately determined by the ordinary methods of surveying would supply much of the desired information at less expense. Experiments are now in progress to determine relative costs, as well as better modes of procedure. Aerial photography may also be of use in keeping maps and charts up to date, especially in areas where changes occur frequently, and in supplying details for places difficult to traverse.

Photographs are useful also in an area where it is desirable to show accurately certain details of open country, such as forested areas, tilled lands, and the quality of roads. This can perhaps be best illustrated by an example.

Mapping of the Camp Abraham Eustis Area, Virginia

The excellent topographic maps of parts of eastern Virginia recently completed by the United States Geological Survey show among other

Fig. 3—A part of Camp Abraham Eustis, Va., showing the mapped area represented by the photographs shown in Figs. 4 and 5. Streams, swamps, woodlands, and clearings are seen. The contour interval is 2 meters; scale 1:10,000. Orientation corresponds with that of Fig. 4. (Drawn from Mulberry Island Sheet, No. 2, Corps of Engineers, U. S. Army, Special Military Map.)

things the general distribution of forests with somewhat indefinite outlines. This is perhaps all that is warranted for most areas, but there are places where more accurate information is needed. It might be desirable to know whether an area mapped as forest is covered with large timber or with worthless brush; whether the forest consists of evergreen or deciduous trees; whether the cleared land is cultivated, pasture land, or overgrown with bushes; whether the roads are well-kept thoroughfares or unfrequented byways. It is important to aviators that maps of areas that lie along airplane routes show cleared tracts where landings can be made in safety. Investigations were carried on in eastern Virginia during the war to determine these and other characteristics of the country, for the purpose of coast

FIG. 4

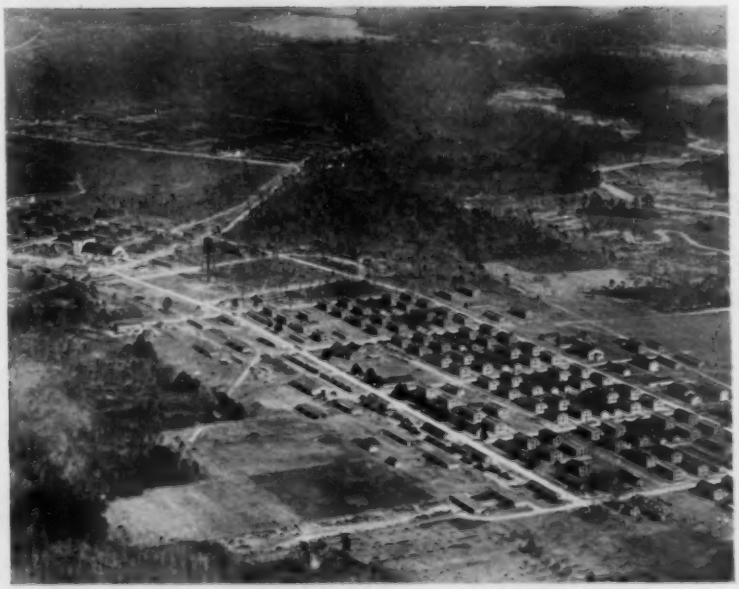

FIG. 5

FIG. 4—Vertical view of a part of Camp Abraham Eustis, Va. This is the area shown in Fig. 3, with which it should be compared. Note the differences in detail, especially as regards the drainage. (Photograph by U. S. Army Air Service.)

FIG. 5—A part of Camp Abraham Eustis, Va., showing in oblique view the area represented by Fig. 3. For orientation note that the meandering stream shown near the bottom of Fig. 3 appears here in the right hand middle ground. To correspond with Figs. 3 and 4 this one should be viewed in reverse position. (Photograph by U. S. Army Air Service.)

defense. Such details may all be obtained by aerial photography with great accuracy and relatively small expense.

To illustrate this point I have chosen the photograph of an area near Camp Abraham Eustis that was mapped with extreme care. This area was mapped on a scale of 1:10,000, or about 6 inches to the mile, and the map shows details with unusual fidelity. The area shown on the part of the map reproduced as Figure 3 was photographed both vertically and obliquely from the air. On comparison of the map with the vertical photo-

FIG. 6—A mud flat off the eastern shore of Virginia, showing channels in an area submerged at high tide and exposed at low tide. (Photograph by U. S. Army Air Service.)

graph (Fig. 4) it is obvious that in spite of the detailed character of the map the photograph shows many details that the map does not represent, such as the small streams in the foreground. Many of these details are too trivial to be worth the expense of mapping, but the photograph records them at no extra expense.

OBSERVATIONS ON AREAS DIFFICULT OF ACCESS

Some of the marshes of the Coastal Plain consist of soft muck and mud through which it would be foolish to attempt to make one's way. Others are equally inhospitable jungles of reedlike grass and similar rank vegetation. It is not strange that the maps of these marshes do not show great detail. The camera, however, is not concerned with the difficulties that the surveyor might encounter. It represents useful and useless details with

equal accuracy. It is somewhat surprising as well as especially interesting to note from photographs of some of these marshes that in addition to the tidal runs or so-called thorofares open at both ends, they have perfectly developed stream systems showing dendritic arrangement with complicated interlacing of branches—beautifully perfect meandering rivers in miniature, a whole system developed on an area of only a few acres.

Details of a Marshy Area

Captain Place photographed some of these marshes during a flight, but unfortunately the weather conditions prevented him from rising more

Fig. 7—Aerial view of a part of Lee Marsh near West Point, Va., showing an intricate system of drainage not indicated on existing maps. The straight lines across the illustration are due to the joining of photographic prints. (Photograph by U. S. Army Air Service.)

than 2,000 feet, hence the photographs include only small portions of the marsh lands. Figure 7 represents a strip of land about three-quarters of a mile long in the extreme southwestern part of Lee Marsh. This figure may be compared with the topographic map of the same area. (See United States Geological Survey map of New Kent quadrangle, Virginia.) The rounded end to the left in the photograph is the relatively pointed projection of the marsh toward the southwest. The larger stream in the upper right hand corner of the photograph is the same as the one mapped as a winding thorofare through the marsh. The complicated system of drainage shown in the body of the photograph is not represented on the map, and this helps to establish one of the points here emphasized, namely, that aerial photography supplies at no extra expense geographic details which do not warrant the expenditure that would be necessary to map them by ordinary methods.

FIG. 8—Above is an aerial photograph of a section of the mouth of the Poquoson River, Va. On the left is seen forest and cultivated land; in the center and to the right marshland. Subaqueous features shown are sand bars, submerged terraces, and inner channels. Sand bars are seen as a light-colored zone of wavy appearance. Currents are longshore, and the bars point upstream. The outer edge of this zone marks the outer edge of a shelf from 3 to 5 feet deep. In the left center it is sharply cut by the navigable channel of Bennett Creek (9 to 22 feet deep) which is clearly distinguished from the submerged shelves on either side. The illustration is made up of three photographs. The diagonal lines across it are due to the joining of the photographic prints. (Photographs by U. S. Army Air Service.) Below is a reproduction of the U. S. Coast and Geodetic Survey chart of the same area.

Other places where aerial photography is useful in supplementing maps and charts are low-lying coasts that are likely to change in form during a storm and areas near the mouth of a stream that is delivering sediment. It is noticeable that in some places shore lines differ from those indicated on maps made several years ago. In some of these low-lying areas there is a wealth of detail that is utterly trivial and would seem superfluous on an ordinary map.

Compare, for example, the photographic reproduction in Figure 8 with the United States Coast and Geodetic Survey chart representing the same area. The photograph covers about a linear mile of the south bank of Poquoson River, a small tributary of Chesapeake Bay south of the mouth of York River. The portion to the right, east of Bennett Creek, is marsh land; that to the left is partly cultivated and partly wooded. In the marsh land may be seen dark-colored areas covered with vegetable growth, light-colored wet places, many minute meandering streams bordered by mud flats covered with water at times of high tide, and several unknown objects. At the left are relatively dark-colored areas of woodland and light-colored roads leading to cultivated fields near the shore. Houses and barns appear as minute dots. The low bluffs along streams appear as sharp lines bordered by a narrow belt of sand or mud exposed at low tide. The sandy beach appears white; the mud darker.

Observations of Subaqueous Bars and Terraces

It is well known that where the water is clear objects submerged to a considerable depth may be seen from points far above the surface. During the war submarines were detected and followed by observers in airplanes, and sunken vessels have been located by aerial observation. It is said that objects in clear water at depths of 45 feet have been successfully photographed and that with the proper plates and ray filters the presence of objects invisible to the eye is revealed by the camera. It is possible to use this method of observation to some extent in detecting and mapping sand bars, shoals, drowned terraces, and channels.

Among aerial photographs taken near Langley Field, Va., several prints were found on which a dark belt appeared near the middle of a stream and lighter-colored belts between it and the stream banks. On comparing the photographs with charts of the areas represented it was found that the dark belts represent deep channels, and the light lateral belts less deeply submerged shoals.

The practical use of such a photograph is illustrated in Figure 8. The inner channel of Bennett Creek, ranging in depth from 9 to 22 feet, is used as a passageway for boats. In the photograph this channel appears distinctly set off from the less deeply submerged shelves on either side. The photograph used in Figure 9 also shows the navigable inner channel.

Some of the photographs, taken along the banks of the larger streams, show sand bars and other details of the bottom in a definite zone, beyond which the area appears characterless. Comparison of these photographs with the Coast Survey charts indicates that beyond a shallow submerged shelf there is a relatively sharp descent to deeper water. This is illustrated in Figure 8, where the outer edge of the zone of sand bars—the light-colored portions of wavy appearance just offshore—marks the outer edge of a shelf which is 3 to 5 feet below water level at low tide. In Bennett Creek, toward the left, this sand is sharply cut by the inner channel. It may be noticed that this central portion appears characterless, doubtless because under the conditions prevailing at the time the photograph was taken the lens was not able to penetrate this depth of water. At the right, however, where soundings indicate a depth of 8 feet of water, certain differences in color suggest unevenness of bottom.

The details of the sand-bar zone are worthy of special note. This area is at the mouth of Poquoson River, where the currents are longshore. These currents carry the sand and heap it up in spits and hooks, which point upstream. The open bay is toward the right, and each mass of sand tends to face toward the left, or upstream, producing a steplike aspect.

But not all the photographs showing coast lines reveal these subaqueous features. Evidently some conditions of atmosphere or water are unfavorable for photographing them. Unfortunately I was not able to ascertain the conditions under which the photographs of these submarine areas were taken. Many of those examined at Langley Field resulted from random shots made by students during practice flights, when no record of altitude or conditions of light, wind, or time of day was obtained. Furthermore, these pictures were taken for the purpose of photographing subaerial rather than submarine objects.

The Photographing of Underwater Features

As relatively little is known of the conditions favorable for photographing underwater objects, a record of certain flights on which such photographs were taken may be useful for future reference. A flight for observation was made with Captain Lawson on May 21, 1920, between 2 P. M. and 3 P. M. Over Langley field we circled to an altitude of 4,000 feet, then flew in a general northerly direction across the mouth of York River, turned eastward around Mobjack Bay to New Point Comfort, and returned over the water to the coast south of the York. Thence we followed a winding course southward over to the mouth of Back River and finally returned to Langley Field. The wind was blowing from the west with sufficient force to produce numerous whitecaps on the bay. The sky was somewhat evenly but thinly overcast, so that the light was fairly strong, but no direct rays from the sun penetrated the clouds.

Under these conditions of light, altitude, and surface of water the following observations were recorded. Over a broad zone near shore, in some places a mile or more in width, submerged objects were seen almost as plainly as objects above water. The white sand bars were particularly conspicuous. In several places three to seven of them were observed in parallel or concentric arrangement like giant ripples. Areas of dark mud and of green vegetation-covered bottom contrasted sharply with the sandy

FIG. 9—Vertical view of Penniman and King's Creek, a southern tributary of York River, Va., showing navigable inner channel at the edge of which is the boat landing, marginal shoals, and sandy beach. The straight diagonal lines are due to the joining of photographic prints. (Photograph by U. S. Army Air Service.)

areas. Some of the dark places seemed to indicate deep water, but this appearance may have been deceptive. The roughness of the water surface, even where whitecaps were numerous, did not interfere seriously with visibility.

The submerged land forms appeared especially conspicuous in Back River, one of the so-called rivers tributary to Chesapeake Bay which are in fact estuaries where the waters of the bay occupy drowned valleys. For 3 miles or more above its mouth Back River is more than a mile wide and less than 6 feet deep, except near the middle, where a relatively narrow channel ranges in depth from 6 to 25 feet. The sinuous course of this channel is plainly discernible from the air. The outer edge of the slightly

submerged shelf appears as a definite line, owing to change in slope of bottom. The boat landing at Amory's Wharf is built where the bottom descends steeply from the submerged shelf to the deep channel.

In many places on this and other estuaries the zone in which the details of bottom were clearly visible terminates at what appeared from our exalted point of observation to be a sharply defined and gently sinuous line. Most of the boat landings are at or near this line, and several beacons were seen near it. Comparison with the Coast Survey charts indicates that at the outer edge of this zone the water at low tide is about 5 feet deep. The line seemed to indicate the presence of a bench with steep outer slope, rather than a uniform slope of bottom.

In nearly all places beyond the shallow water there appeared a zone of variable width which was of a dark chocolate-brown color, darker than that near shore, but few details of the bottom could be distinguished. There are numerous fish traps and nets in this zone, many more than were observed in the shallower water. At the mouth of York River and at several places in Mobjack Bay the chocolate-colored zone terminated at a dim but plainly discernible line, beyond which the water appeared dark and characterless. Near its outer edge are the larger lighthouses such as the one at the mouth of York River off Godwin Island and those off Tow Steak Point and Wares Neck Point. The landing at Bay Side Wharf, north of New Point Comfort, is also near the outer edge of this zone. Reference to the charts indicates that the water at this landing is 12 feet or more in depth and that the lighthouses are at the outer edge of a shelf where the water is 10 or 12 feet deep. Beyond this shelf the bottom falls away sharply to deep water. It may therefore be inferred that the dark-colored characterless area near the mouth of the York River represents the deep inner channel, where the water is 25 to 70 feet deep. It may further be inferred that the dim line between the chocolate-colored zone and the dark inner channel denotes the relatively sharp descent of the bottom at the edge of a submerged shelf. These inferences, however, must be regarded as tentative and should be verified by further observations.

In studying the underwater features as shown in photographs caution and careful checking in every way possible are necessary. Changes in hue in the photograph might be due to sediment in suspension rather than to differences in depth of water. This was made obvious by the flights over the Potomac River referred to below.

Observations on the Potomac River

As the observations near Langley Field proved that shoals and channels can be photographed from the air, it seemed possible that drowned terraces and valleys such as those of Potomac River might be successfully shown in this way. To test this possibility several flights were made from Washington, D. C. Here the conditions were found to be quite different from those

FIG. 10

FIG. 11

FIG. 10—Potomac River and the lower end of Potomac Park at Washington, D. C., showing in the foreground the deep channel, light because of muddy water; the submerged shoal, with dark, weedy bottom showing through 2 to 5 feet of clear water; and a narrow channel 8 to 10 feet deep along the wall of the Park. The Anacostia River and Hydroplane Station appear in the distance. (Photograph by the author.)

FIG. 11—Underwater channels and shoals in Potomac River and Piscataway Creek. The channels appear light-colored because filled with muddy water. The dark shoals show through the clear water which is 2 to 5 feet deep. (Photograph by the author.)

on Chesapeake Bay. In the clear water of the bay dark color indicates depth, but in the river the deep water of the main channel was turbid and appeared light-colored (Fig. 10), while the shallow water on the broad drowned terrace was clear and appeared dark-colored because of weeds growing on the bottom. The inner channel of each tributary stream was also seen plainly (Fig. 11). Most of the tributaries entering from the hills to the west contained light-colored turbid storm water which followed the drowned channel through the clear shallow water on the dark-colored shelf to the main channel of the river. On the opposite side, where the tributaries are short and drain low land few of them contained turbid storm water. The deep inner channels here appeared darker than the drowned terrace in which they are cut. Every channel on either side was sufficiently clear to be successfully photographed. A channel filled with clear water appears in the photographic print as a dark belt; a channel filled with opaque muddy water appears light-colored. However, this light-colored portion indicates only the approximate position of the channel, because the muddy water gradually mingles with the quiet shallow water on the shelf.

Aerial Photography As an Aid to Physiographic Interpretation

The possibility of recognizing shoals and channels from a photographic print and of determining in some measure the shape of submerged land forms opens a new avenue of approach to the study of submarine geography. In some places, especially in a drowned region, aerial photography may be used with success in working out the physiographic processes that have produced the drowned land forms and thus assist in solving some vexed questions in earth history.

There is also a practical aspect of the subject, for photographic representations of shoals and channels can be used in making navigation charts and in keeping up-to-date charts of areas that undergo changes. With a photograph such as that of King's Creek (Fig. 9), a boatman should have no difficulty in avoiding shallow water. Many of the tributary channels of the Potomac and other rivers of the Coastal Plain are not charted, and some have changed since charts of them were made. Small craft on the Potomac frequently go aground where the water was supposed to be deep enough to float them. Aerial photographs showing the position of the channel in critical places might be of use.

So far as I have been able to ascertain little is definitely known of the conditions most favorable for obtaining photographs of submarine objects. It is annoyingly obvious to the aerial observer that at certain times he can see nothing beneath the surface, though at other times he can see underwater objects with great distinctness. In trying to ascertain the most favorable conditions for such observations, it was found that these objects are seen plainly when the sky is evenly overcast or when it is uniformly clear. Sometimes when the sky is only partly cloudy the surface of the

water seems to act as a mirror, and nothing is seen but reflection of cloud and sky. Waves seem to have little effect on the visibility of objects beneath them except to diffuse the reflected sunlight. This reflected light is stronger than that coming from submerged objects and destroys the effect of those objects on the photographic plate. Hence to photograph underwater features successfully a time should be chosen when direct reflection of light from the sun or from a brightly illuminated cloud will not enter the lens.

Both experience in the air and experiments in the laboratory show that the best results are likely to be obtained early in the morning or late in the afternoon, under an evenly illuminated sky. But experience also indicates that there are unknown factors which affect the results. It is a puzzling fact that the photographs taken at some moments when the eye caught the image of submerged objects show only the surface of the water.

There is need of careful research to determine the conditions under which the best results may be obtained. The height and the time of day for exposure with a certain lens, the emulsion and kind of ray filter best suited under certain conditions, the effect of refraction of light as it enters and emerges from the water, and the effect of polarization are subjects demanding serious consideration.

A METHOD OF AEROPHOTOGRAPHIC MAPPING*

By Fred H. Moffit
United States Geological Survey

This paper is not intended to be the description of a finished piece of work but rather is a report of progress in the development of a method of mapping which is only in a formative stage. It will not do therefore to expect that details will be given with the greatest accuracy and that all the problems connected with the work have been solved, although the general principles on which the method is based are fully established. We believe that the direction for progress has been pointed out but that many steps remain to be taken.

The work to be described is the outgrowth of experience in using the panoramic camera for topographic mapping in Alaska during the last eight years. The panoramic camera was first used in the Alaskan work of the Geological Survey by C. W. Wright in 1904, but it was not till after Wright had left the Survey and the work he began was taken over by Mr. J. W. Bagley, now Major Bagley, that the panoramic camera became one of the instruments regularly used for topographic mapping in Alaska.[1] The opportunity to take up and carry on this method was due primarily to Mr. A. H. Brooks, now Lieutenant Colonel Brooks, Chief of the Alaskan Division.

With the outbreak of the war in Europe and the rapid development of the airplane for military purposes the camera immediately took an important place as a means for gathering military information, including the making of maps. Major Bagley turned his attention to this broader field for the camera and asked the writer, who had had some small part in the previous work, to assist him. As progress was made it was found that more assistance was needed, particularly in photography, but also in many other ways, and Mr. J. B. Mertie was invited to contribute the benefit of his experience.

These investigations, which at first were carried on under the direction of the Council of National Defense and Mr. Brooks of the Alaskan Division of the Geological Survey, were later taken in charge by the Corps of Engineers of the Army and Lieutenant Colonel Marshall of the Topographic Branch of the Survey where they have remained to the present time. Money for the first experiments was furnished by the Council of National Defense, but the large sum needed for the construction of airplane cameras and transforming cameras was allotted by the Engineer Corps.

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*This paper (published with the permission of the Director of the United States Geological Survey) was read at the meeting of the Association of American Geographers at Baltimore in December, 1918. The writer takes this opportunity to express to Lieutenant Colonel Marshall, under whose immediate direction he has worked during the last year, his appreciation of the enthusiasm and generous encouragement given Major Bagley and himself.

[1] J. W. Bagley: The Use of the Panoramic Camera in Topographic Surveying, *U. S. Geol. Survey Bull. 657*, Washington, D. C., 1917.

Principle and Problems of Airplane Mapping

The fundamental principle on which these investigations is based was first expressed, so far as the writer knows, by Theodor Scheimpflug, an Austrian army engineer, who gave many years of his life to the study of the problem. He, however, lived before the days of the airplane, so that his methods did not meet with the full success they deserved and he died without seeing any extensive application of them.

If a camera is carried above a horizontal plain and an exposure is made with the sensitive plate parallel to the plain, the resulting picture is a map whose scale is dependent on the focal length of the taking lens and the height of the camera above the plain. We apparently have at hand, then, a simpler way for making maps of many regions than the way ordinarily employed, for the airplane makes it possible to pass back and forth over a chosen area at will. Yet two difficulties are met when airplane photographs are employed in making maps. First, it is impracticable if not impossible with any means yet devised to keep the camera in a horizontal position; second, the angle of view of the fast lenses which must be employed in taking photographs from airplanes is small, so that the area covered at each exposure is also small and a great number of pictures must be taken in constructing the map. These, then, are the first problems that must be taken up if an accurate map is to be made at less expense than by the usual surveying methods.

The investigation to be described falls naturally into two divisions, of which the first deals with the airplane camera, that is with photographing the terrain. To this Major Bagley gave his attention. The second has to do with correcting the inclined airplane pictures; and for the study of the principles involved and the design of the transforming camera the writer is responsible. The questions relating to photographic methods and the construction of charts and computing devices for use with the transforming camera fell to Mr. Mertie.

The Airplane Camera

The difficulty of obtaining a lens which shall have speed and at the same time a wide angle of view is met by constructing a multiple camera with its three lenses and focal planes so arranged that the central plane shall be in a horizontal position and the other two shall be inclined at a fixed angle to it. The side pictures, because of their inclination, include areas outside the field of the central picture but overlap it slightly so as to give the means for joining them. A photograph of such a camera is shown in Figure 1.

The camera is about 25 inches high, 22 inches wide, and 7 inches thick from front to back. It consists of two parts, which may be separated from each other. The upper part is the magazine which carries the roll film. The lower part is really three distinct camera boxes, each fitted with its own lens and shutter, joined together.

The two side focal planes of the camera are inclined to the central plane at an angle of 35 degrees, and as a consequence the angle between the axes of the two side lenses and the central lens is the same. Lenses of about 7-inch focal length are used on the two side boxes and one of about 6 inches on the central box. The automatic shutters (Fig. 2) are released by a special cable release which acts on the triggers of the shutters through a synchronizing device shown in the photograph. This release is so adjusted that the shutters open and close at exactly the same instant. It is necessary that the time of exposure shall be as short as possible in order that a sharp image may be obtained. This necessity is the result of several causes, chief of which are the vibration of the engine and the angular movement or roll of the plane.

FIG. 1—Front view of the airplane camera showing the crank for winding the film and the index of the film measuring device.

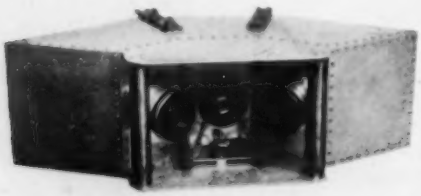

FIG. 2—The bottom of the airplane camera showing the lenses and the synchronizing advice.

When a film is to be inserted in the camera the magazine is lifted off the boxes, the unexposed spool is placed in position in its supports near the center of the magazine, and the free end is attached to the winding spool in the top of the magazine. After being replaced the magazine is made fast to the lower part by thumbscrews which bring the two sides closely together and prevent the entrance of light.

The film is wound off by hand by the crank seen in the illustration (Fig. 3). A registering device shows the length of film turned off when the crank is turned, and a marking device makes a mark on the film whenever the release is operated, so that the film may be cut without spoiling a negative. The film is 5 inches wide and has a maximum length of about 400 feet. The individual negatives are 5 inches wide and 6 inches long.

To mount the camera in the airplane a hole is cut in the bottom of the fuselage in front of the observer's seat, and a cradle, closed below by a sliding door for the protection of the lenses, is fastened securely to the floor. This cradle is padded with felt or sponge rubber, and the camera is strapped securely in it. Some airplane cameras are mounted on gimbal rings whose movement is damped by a dashpot arrangement. Such a mounting has

been constructed for this camera but has not yet been tried out. It is not expected that this mounting will keep the camera in its proper position, for seemingly no device dependent on gravity alone for its effect has been able to do this fully. Probably it can do no more than reduce the errors of deviation.

Making the Exposures

The frequency with which exposures are made at a given altitude in getting pictures with proper overlap depends on the rate of movement of the plane over the ground, which in turn is dependent (1) on the airplane itself and (2) on the movement of the surrounding air; for the speed of the plane referred to the ground may be greatly increased or retarded as the plane flies with or against the wind. The time interval between exposures varies roughly from one-quarter minute to one minute. The observer making the exposures, however, does not rely on a time interval for getting properly spaced pictures but is chiefly dependent on a large negative lens about 6 inches square which is set in the bottom of the fuselage and enables him, as he views objects below him, to judge both the direction and the rate of movement over the terrain.

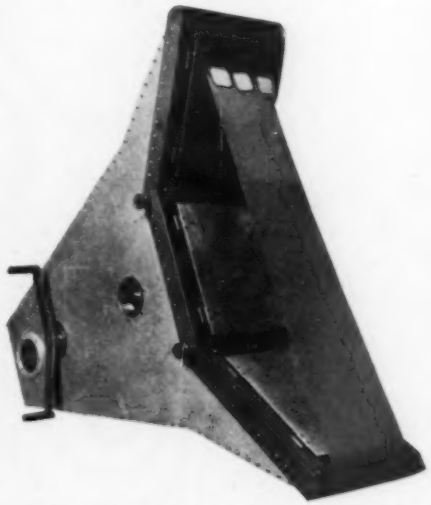

Fig. 3—The top of the airplane camera showing a film being inserted and the aluminum plates which indicate the position of the focal planes.

This camera still lacks one essential feature necessary to make it fill its purpose fully. It should have incorporated in it a device for recording on the film at the time of exposure the amount and the direction of the tilt of the central plate, for, as has been stated, it is not yet possible to keep the camera in a horizontal position. Correction of this fault appears to be only a matter of adapting to the camera some such principle as that of the gyroscope on which others have been at work and which seems now to be brought to a condition for practical application in this place.[2]

The Transforming Camera

Pictures taken with the airplane camera just described are subject to errors arising from the construction of the camera itself and from the tilt of the airplane, for it is only when the plate is taken in a horizontal position

[2] Since this paper was written Lieutenant W. A. Hyde, of the Science and Research Division of the Air Service, and the writer have constructed a pendulous camera whose motions are damped by a gyroscope and have obtained encouraging results. This investigation is still in progress.

that the resulting picture is a map. These errors may be corrected graphically by projecting chosen points one by one on a plane representing the plane of the horizon, but the process is long and tedious. It was for the purpose of making these projections photographically that the transforming camera was designed.

Principles of Construction

Before describing the working of the transforming camera it is desirable to state two principles on which the construction of the instrument is based.

Let $A\ P_1$ and $A\ P_2$ (Fig. 4) be two planes intersecting in the line A, and through any point O pass planes C_2O and C_1O parallel to planes $A\ P_1$ and $A\ P_2$ respectively. Project point a through point O onto the plane $A\ P_2$ in a'.

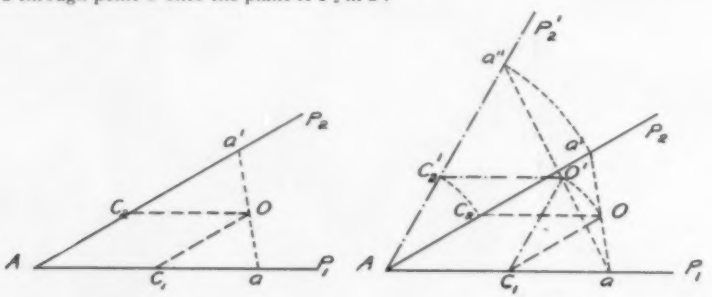

Fig. 4 (a) Fig 4 (b)

Now if we revolve the plane $A\ P_2$ about line A, the point a' is revolved to a'', the point C_2 to C'_2, and O to O'; and it may be demonstrated that the points a, O', and a'' lie in the same straight line, that is O' remains the center of projection for point a and its projection a'' on the revolved plane $A\ P'_2$.

This principle has an important use in the construction of the transforming camera. The second principle deals with lenses.

Let O (Fig. 5) be a lens of focal length f, whose axis is perpendicular to the plane passing through the optical center of the lens and the intersection of two planes $A\ P_1$ and $A\ P_2$. Further let O be so situated that it lies on the line which joins a, the intersection of $A\ P_1$ with a plane whose distance from O is twice the focal length, to b, the intersection of $A\ P_2$ with a plane whose distance from O is also equal to twice the focal distance.

These conditions may be expressed in a slightly different way, thus: Let the plane of the lens O pass through the intersection of the planes $A\ P_1$ and $A\ P_2$, and let O lie in the intersection of two planes C_1O and C_2O, which are parallel respectively to $A\ P_2$ and $A\ P_1$ and pass through the intersections of planes $A\ P_1$ and $A\ P_2$ with the focal planes of the camera.

If these two conditions are satisfied it may be proved that all points on either plane $A\ P_1$ or $A\ P_2$ are sharply in focus on the other plane.

This fact is the second principle which we need to use. Let us now see how these principles are applied to the correction of pictures taken in an inclined position.

Let P_2 (Fig. 6 a) be a negative on which are photographed the points A, B, and C. Let f be the focal length of the lens, i the angle of inclination of the plate, and D the height of the camera above the ground. The points a, b, and c are images of A, B, and C. Now the size

of the image a, b, c, with any given inclination i, depends on the focal length of the lens and the height of the camera above the ground. This inclined photograph does not show a, b, and c in their true relative positions, but it can be made to do so by projecting the image onto some plane parallel to A B, such as P_1; and the scale of the resulting image depends on h, the distance of the plane P_1 from O. In order to show how this projection may be made photographically, produce the planes P_1 and P_2 till they intersect in A (Fig. 6 b), and draw C_2O and C_1O through O parallel to A P_1 and A P_2. Also replace the lens of the taking camera by another lens whose focal length is f_3, the length of the perpendicular let fall from either C_1 or C_2 to A O. It should be noted that A O is the plane of the new lens. We have now

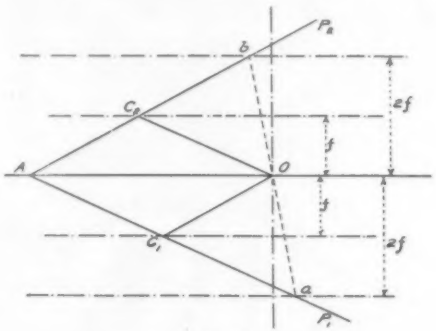

FIG. 5

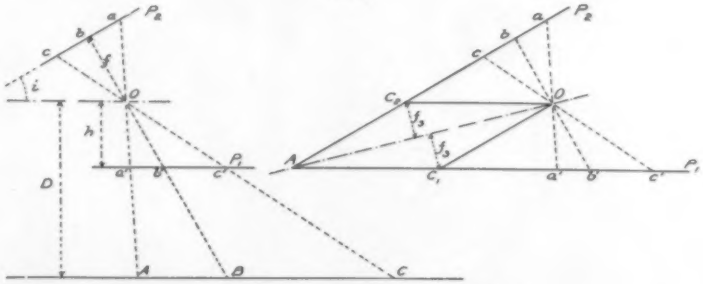

FIG. 6 (a) FIG. 6 (b)

fulfilled the conditions that must be fulfilled if we are to obtain sharp images of the points a, b, and c on the plane P; but we have limited ourselves to the use of one lens in making any given projection and shall require a different lens for every different angle of inclination. If, however, we revolve plane P_2 about the axis A we may vary the distance f_3 and thus, within certain limits, adapt our figure to whatever lens we find it convenient to use in the transforming camera. In the description so far the separation of the principal points of the lens has been disregarded. This was done to simplify the description and is entirely proper, for the same conclusions would have been reached had this been taken into consideration.

FORM OF CAMERA

The simplest form of transforming camera capable of transforming photographs taken at different angles of inclination is one in which the two sides are hinged together and have their line of intersection in the plane of the lens. Such a camera is impracticable if the angle of inclination is small or

has a wide range of values. The form of camera we have been using is shown in Figure 7. The two sides instead of being hinged together are made to revolve about vertical axes, and they together with the lens are capable of movements that permit all the conditions indicated in the previous diagram to be satisfied. The vertical axes may be moved to and from the lens, and in addition one axis and the lens may be moved transversely. The two axes are so connected with the frame supporting the lens that they and the lens are always in line. The large disks supporting the negative and the sensitive plate may be moved horizontally in their own planes.

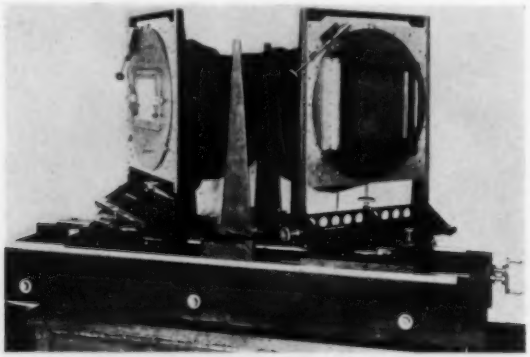

FIG. 7—The transforming camera. The sides are inclined toward each other showing the revolving disks on which the negative and the plate holder are carried.

The transforming camera is an instrument for doing accurate work. It is necessary that the films or plates be put exactly in their proper positions and that the settings of the scales be correct.

In setting up the transforming camera it is assumed that the focal lengths of all lenses employed, both in the airplane camera and in the transforming camera, are known and that the inclination of the picture to the horizon plane is known or can be found. With these data the setting of the instrument can be made after certain simple trigonometric calculations are completed, or the setting may be taken from charts constructed for the purpose. The charts are graphical representations of the trigonometric formulae and simplify greatly the work of making transformations. The camera is provided with scales and verniers so that the settings may be made with the required accuracy. It is not necessary to give here the formulae for obtaining the settings, but it should be said that it is nearly always best to have the solutions represented graphically.

TRANSFORMATION OF PHOTOGRAPHS

The inclined airplane photograph shows distant objects on a smaller scale than the near objects, so that the problem of the transformer is to restore a

uniform scale to the picture by enlarging or reducing some part of it. Ordinarily one part of the photograph is enlarged, another is reduced, and the two parts are separated by a line where no change has taken place. Figure 8 shows one of the side pictures before and after its transformation.

The procedure followed so far in working up the airplane photographs is first to transform the side pictures to the plane of the central picture (Fig. 9), and when necessary all three to the horizontal plane, and then by an independent operation to bring all the pictures to the required scale, which, as a rule, is much smaller than the approximately 1:10,000 scale on which the original pictures were taken. After being brought to the chosen scale the pictures are cut to fit and joined together (Fig. 10). A certain amount of independent horizontal control is needed in this method of mapping as in all others, particularly if an extensive area is to be mapped, but our experience is not yet wide enough to show just how much of such control will be required. It will of course depend in part on the scale of the map.

Difficulties in Aerophotographic Mapping

The chief sources of difficulty that arise in making maps from airplane photographs lie (1) in the lack of suitable means for obtaining the data for transforming the inclined pictures into a truly horizontal position and (2) in the errors introduced into the pictures by relief of the terrain. The first of these has already been spoken of in describing the airplane camera and will be solved by installing in the camera the means for recording on the film at the time of exposure the direction and amount of inclination of the central negative. It may be solved in another way if sufficient horizontal control is available, for three or more points on the photograph may be brought into coincidence with corresponding known points plotted on the ground glass of the transforming camera, or rather on a tracing paper which can be compared directly with the image on the ground glass, and this of itself brings the picture into the horizontal position.

Error Due to Relief of Terrain

The second source of difficulty, or that arising from relief of the terrain, becomes of greater and greater importance as the relief increases. If the scale of the map is large the error must be taken into consideration even when the relief is small. Apparently the errors of relief cannot be corrected directly by photographic means, and for the proper location of individual points it becomes necessary to determine the station point, or the point on the ground directly below the camera at the moment of exposure, and to find the position of the desired points by intersections from two photographs. This adds an extra operation to the work, which it is desirable to avoid where possible. Another line of attack on the errors brought in by relief is through the properties of stereoscopic vision. This

FIG. 8—On the left one of the side pictures taken with the airplane camera; on the right the same picture after it has been transformed to the plane of the horizon. About two-fifths the size of the original photographs.

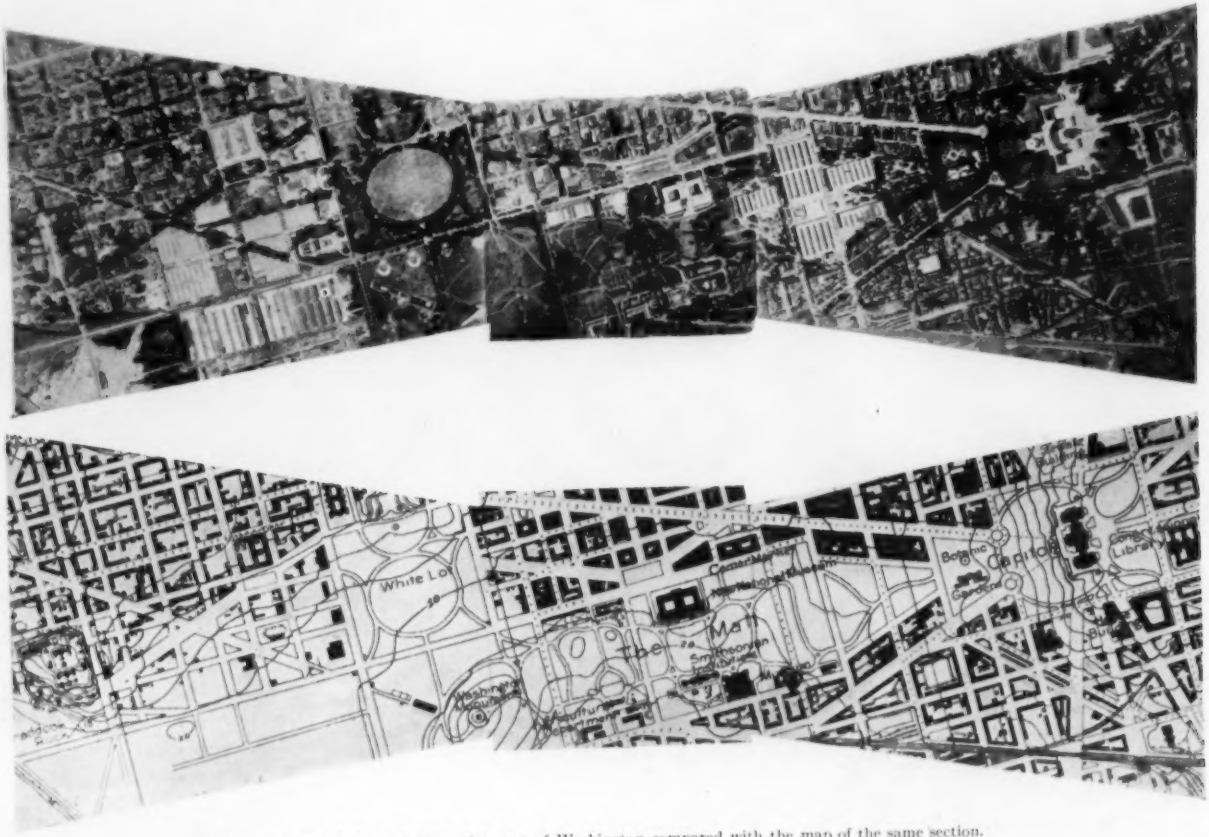

FIG. 9—A set of three pictures of a part of Washington compared with the map of the same section.

involves the use of overlapping pictures and some instrument such as the stereocomparator, constructed for accurately measuring parallax, which may be employed in correcting errors of relief and, if the necessary data are obtained, affords a refined method of drawing the contours to express the relief. This important part of the work is a feature on which we have hardly touched as yet. Fortunately a certain amount of error due to relief comes within the error allowable for the scale of the maps usually made in this country. "Mosaic" is a term commonly employed to designate most of the maps made from airplane photographs. It will be of interest to make a comparison between such maps and maps made by the method just decribed.

Advantages of Multiple and Transforming Cameras

The advantages of the method under consideration may be divided into two classes, those arising from the use of the multiple camera and those due to the use of the transforming camera. It will be well to state again that there would be no advantage in the use of a multiple camera if it were possible to get well corrected fast lenses of wide angle. The chief advantage of the multiple camera over the single-lens camera is the increased field of view which makes it possible to cover a given area with fewer flights and therefore in shorter time and at less expense. The area covered by the three pictures of the three-lens camera at a given elevation is about four times the area covered by the central picture alone, and this is roughly the ratio that holds between the three-lens camera and most of the single-lens cameras. Further the three-lens camera reduces the probability of leaving parts of the terrain unphotographed and makes easier the final assembly of the pictures. A uniform overlap in the series of pictures made during successive parallel flights is difficult to maintain, so that frequently it is found either that the overlap is too great or that a part of the terrain is unphotographed. A wide field of view in the airplane camera helps to minimize this difficulty.

The advantage due to the use of the transforming camera is chiefly that it makes possible the use of pictures that without it would be unusable or greatly in error because the subject photographed was not parallel to the plate and therefore the pictures do not have a uniform scale; but no advantages arising from it are such that they may not be enjoyed in either method. It would be much more nearly correct to say that until the means is devised for keeping the camera plate in a horizontal position the transforming camera is essential to either method if accurate work is to be done. So far as the writer's knowledge goes no airplane camera has yet been constructed whose pictures are not subject in some degree to errors arising from the tilt of the plane. In practically all this, error may be and often is much greater than any allowable error.

The Possibilities of Aerophotographic Mapping

The advantages that will arise from the use of photographs taken from the airplane or dirigible airship for the making of maps can hardly be overestimated. These advantages are of many kinds and include among others greatly increased speed, greater accuracy in details, reduction in cost, and, for special purposes such as the use of aircraft pilots, the possibility of representing on the map the actual appearance of the terrain as it is seen

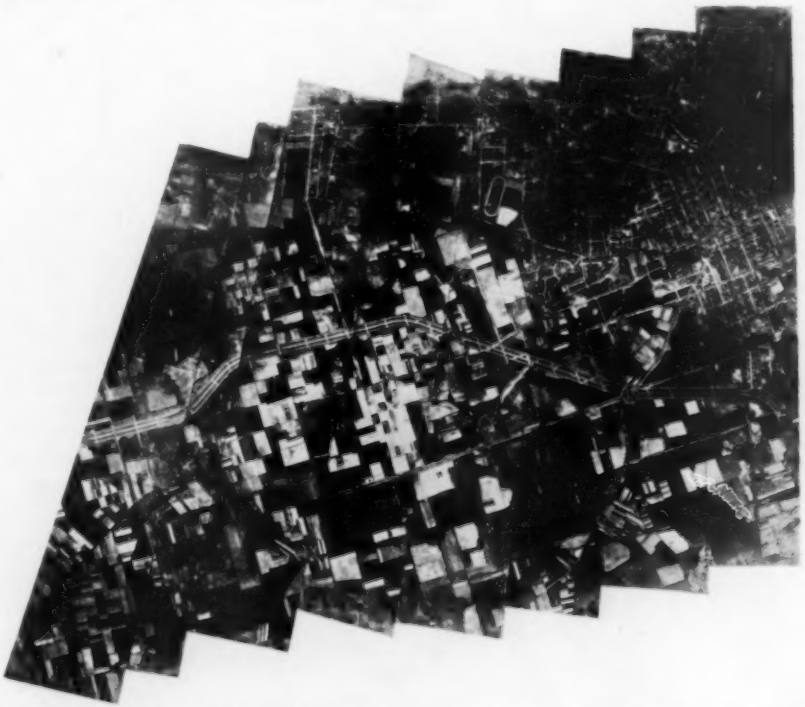

Fig. 10—A series of photographs taken with the airplane camera after they have been reduced to the horizontal plane and joined together.

from above. Further it will make possible the mapping of areas which for the lack of roads and other means of transportation or for other reasons are now practically inaccessible. When a strip of country from three to five or more miles wide can be photographed at the rate of seventy-five or one hundred linear miles per hour, according to the speed of the airplane, it is not difficult to see that the length of time per square mile devoted to actual field work in the older, established methods now in use must be even hundreds of times greater than in the new method.

The errors that arise from the relief of the terrain have been referred to and are fully appreciated, and for that reason it is believed that the first

application of the method should be in areas of low relief. Many thousands of square miles of such land are still unmapped in the United States, including most of the Atlantic and Gulf Coastal Plain as well as great areas in the west. The Coastal Plain in particular is well adapted to test the merits of the photographic method of mapping, for it is a region of low relief, largely unmapped, and in many parts extremely difficult of access.[3] Another field of application in which it is believed that the photographic method will be most useful is in the revision of existing maps, as in the addition of features like new roads built since the map was made or of timbered areas not mapped originally. Only those who have had experience in the study of airplane photographs can realize fully the wealth of material they contain for the map maker.

[3] Compare the preceding article by W. T. Lee: Airplanes and Geography, pp. 310–325.

A NEW SERIES OF SUNSHINE MAPS OF THE UNITED STATES*

By ROBERT DEC. WARD
Harvard University

Sunshine charts are of two classes. They either (1) give the number of hours of bright sunshine, as determined by means of sunshine recorders; or (2) they show the duration of sunshine in percentages of the possible duration. These percentages may be obtained from the cloudiness estimated by eye at regular hours, or by comparing the total number of hours of bright sunshine, as indicated by sunshine recorders, with the total possible number of hours and expressing the results as percentages. When eye observations of cloudiness are available, but sufficient instrumental records of sunshine are lacking, the former method is the one naturally adopted. Sunshine charts of both kinds have been published for the United States.[1] For publication in the forthcoming section on "Climate" in the "Atlas of American Agriculture," a new series of sunshine maps of the United States has recently been prepared by Mr. Joseph Burton Kincer, of the U. S. Weather Bureau. In view of the long delay in the issue of the "Atlas," these new maps have been given advance publication in the *Monthly Weather Review*.[2]

Each of the methods of presenting sunshine data has its advantages, and Mr. Kincer makes use of both. Charts and curves show the mean solar time of sunrise and sunset and the average length of the day (sunrise to sunset), representing the possible maximum amount of sunshine for different seasons of the year. There are charts indicating, for each month, the average amount of sunshine in hours per day; also charts and curves showing the seasonal and annual distribution in percentages of the possible amount and the percentage of days clear, partly cloudy, and cloudy. The diurnal distribution of sunshine is presented graphically. A table gives, for each month and for the year, the average percentages of the possible amount of sunshine for all stations where continuous automatic records are made. This includes practically all regular reporting stations. The basic data are for the uniform period of 20 years, 1895 to

* This is the sixth in a series of articles by the present writer on the climatology of the United States. The previous articles were: Climatic Subdivisions of the United States, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 672–680; Rainfall Types of the United States, *Geogr. Rev.*, Vol. 4, 1917, pp. 131–144; Rainy Days and Rain Probability in the United States, Vol. 7, 1919, pp. 44–48; Frost in the United States, *Geogr. Rev.*, Vol. 7, 1919, pp. 339–344; Cloudiness in the United States, *Geogr. Rev.*, Vol. 9, 1920, pp. 347–356; New Monthly and Seasonal Rainfall Maps of the United States, *Geogr. Rev.*, Vol. 10, pp. 173–181.

[1] See R. DeC. Ward: Bibliographic Note on Sunshine in the United States, *Monthly Weather Rev.*, Vol. 47, Nov., 1919, pp. 794–795.

[2] J. B. Kincer: Sunshine in the United States, *Monthly Weather Rev.*, Vol. 48, Jan., 1920, pp. 12–17.

1914. The percentages of the possible amounts are for the eight-year period 1905-1912. Mr. Kincer's charts and text, inasmuch as they are based on data covering the same period of time, will doubtless for many years remain the standard discussion of the sunshine of the United States.

The map below (Fig. 1), redrawn, with the addition of shading, from Chart I of Mr. Kincer's paper, shows the distribution of sunshine for the year, expressed in percentages of the possible amount. The latter is essentially the same for all parts of the country, the average possible

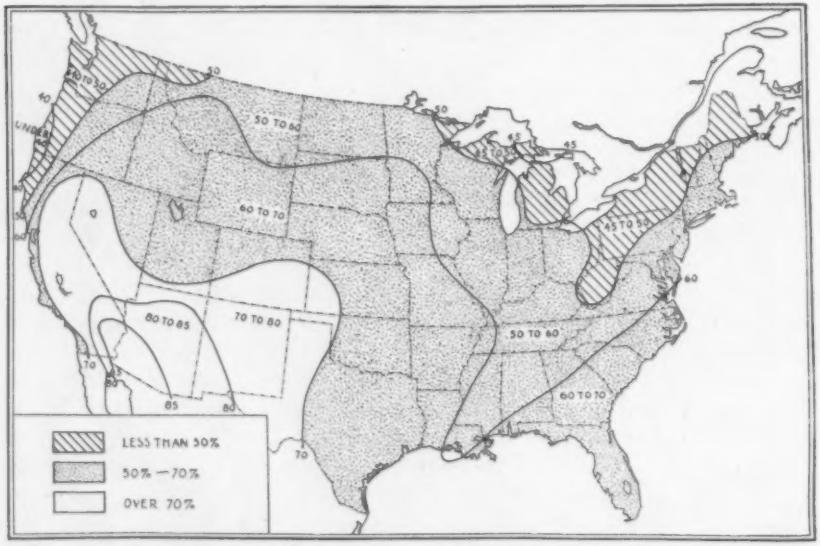

FIG. 1—Map of the United States showing mean annual sunshine expressed in percentages of the possible amount. Scale 1:45,000,000 (after J. B. Kincer).

yearly amount at latitude 25° N. being 4,437.2 hours and at latitude 49° N. 4,472.6 for a 365-day year. The maximum percentage of sunshine (over 85 per cent) is in the extreme southwestern interior. The minimum (under 40 per cent) is along the northern Pacific coast. The Lake region, the northern and central portions of the Appalachian area, and the northeast, have slightly higher percentages (45 to 50 per cent). Elsewhere east of the Mississippi River and over the northern tier of states from the Upper Great Lakes westward to the Rockies, the percentages range from 50 to 60. They are somewhat higher in the southeast, especially in the Florida peninsula. Between the Mississippi River and the Rocky Mountains the annual percentage is generally between 60 and 70, and the same values hold for the central Rocky Mountain region and northern Plateau states. There is thus seen to be a decrease in the amount of sunshine from the southwestern interior to the northwest, north, and north-

east and, to a less degree, to the east. For the United States as a whole the average annual amount of sunshine is about 60 per cent of the possible amount.

The sunshine conditions for the four seasons, given in percentages of the possible, show, for the country as a whole, 48 per cent in winter, 60 per cent in spring, 68 per cent in summer, and 60 per cent in autumn. The maximum seasonal amount of sunshine is 95 per cent—in the valley of California in summer. The minimum amount is under 30 per cent—over the northwest in winter. The annual variation is greatest in the northwest and over the Great Lakes. Both of these regions have marked seasonal variations in cyclonic activity, and both have marked effects of water areas upon the moisture-content of the prevailing winds. The charts showing the average number of hours of bright sunshine daily, by months, indicate quite emphatically the general northward migration of summer conditions, with more sunshine as the season advances from the colder to the warmer months. The summer months are the sunniest in most sections, while spring and autumn have the most sunshine over certain smaller areas. July is the time of maximum sunshine over about one-half of the country. The increase in the amount of sunshine from winter to summer is very marked over the northern portion of the United States.

The annual percentages of clear, partly cloudy, and cloudy days have also been charted. The percentage of clear days ranges from about 20-25 per cent on the northern Pacific coast and over the Lake region to over 90 per cent in the extreme southwestern interior—in southeastern California and southwestern Arizona. On the other hand, the percentage of cloudy days is at a minimum (5 per cent) in the last-named district and at a maximum (over 40 per cent) in the other two areas. For the country as a whole there is less sunshine in the early morning hours; there is a secondary minimum in the late afternoon, and a maximum near noon. This general rule and the departures from it may be explained by the conditions of local cloud or fog formation.

Many interesting comparisons suggest themselves as regards sunshine between Europe and the United States. The contrast between western Europe and eastern North America was clearly emphasized by Woeikof a number of years ago.[3] He pointed out that the American coast has great advantages in respect to sunshine, especially if stations having similar temperatures and not stations in the same latitudes are considered. "Not only is the duration of sunshine longer (on the American coast) but the air is clearer, especially in the colder months. This contrast is very strikingly emphasized on the voyage from England to the United States."

[3] A. Woeikof: Die Klimate der Erde, Jena, 1887, Part II, p. 45.

GEOGRAPHICAL RECORD

NORTH AMERICA

Swamp Lands of Georgia. In 1911 the Geological Survey of Georgia, in co-operation with the Office of Experiment Stations of the United States Department of Agriculture, published Bulletin 25, "A Preliminary Report on Drainage Reclamation in Georgia." This included an introductory chapter and a description of Okefinokee Swamp by S. W. McCallie, the state geologist, descriptions of a few particular counties and localities by the representatives of the government, and a proposed drainage law. The investigations have been con-

FIG. 1—Map showing the geographical divisions of Georgia. Descriptions of most of the divisions can be found in *Annals New York Acad. of Sci.*, Vol. 17, Part I, 1906, and in *Geol. Survey of Georgia, Bull. 26*, 1912. The map is simplified from one used in *School Sci. and Math.*, (Vol. 18, 1918, p. 704) and in *High School Quarterly* (Vol. 7, 1919, p. 255).

tinued in Bulletin 32 of the same series, published early in 1918, entitled "Agricultural Drainage in Georgia," by H[arry]. H. Barrows and J. V. Phillips of the U. S. Department of Agriculture and J. E. Brantly, assistant state geologist. It contains some interesting data about the area of swamps and other wet lands in the state, together with a discussion of methods recommended for reducing that area.

In this bulletin the physiography of the state is briefly described, with a map showing seven divisions, four above the fall line and only three in the coastal plain. The treatment of the coastal plain is decidedly inferior to that of Otto Veatch, who mapped six divisions of it a few years earlier in Bulletin 26 of the same series (reviewed in *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 920–923.) A few pages are devoted to climate, with special reference to exceptionally heavy rains that should be provided for in drainage projects, but little atten-

tion is paid to the marked differences in seasonal distribution of precipitation in different parts of the state.

Generally speaking, the amount of swamp land in Georgia increases from north to south, not only because the northern part is mountainous and maturely dissected and the southern comparatively low and flat, but also because near the coast most of the rain comes in the warmer months, thus tending to counterbalance the evaporation to a considerable extent and keep the water level uniform. In the three mountainous divisions there is practically no swamp, but in the Piedmont region there is a peculiar drainage problem which is largely a result of civilization. There are no natural ponds and few real swamps in that region, but in the many decades that the land has been cultivated a great deal of sand and silt has been washed from the hilly fields into the stream channels, partly obstructing some of the smaller ones and causing them to be flooded when heavy rains run off the denuded surfaces, with consequent damage to crops in the bottom lands. By deepening and straightening the channels the flood waters are carried off more quickly, and this has been done in the last few years in several Piedmont counties.

In the coastal plain, and especially in the lower and flatter portions thereof, conditions are quite different. On account of the sandy soil and gentle slopes and small area cultivated there is very little soil wash, but several kinds of natural swamps are common. Nearly every stream is bordered by swamp, and in flat interstream areas there are numerous shallow depressions, usually occupied by cypress pond or "bay" vegetation. Some of the swamps and ponds have moderately fertile clayey soil and have been drained for agricultural purposes, while others are so sandy that it would hardly be worth while to drain them. Near the coast the salt and brackish marshes at sea level present still other problems, which are common to almost the entire Atlantic coast of the United States.

ESTIMATED PERCENTAGES OF SWAMP LAND IN GEORGIA, BY REGIONS

REGIONS	FROM SOIL SURVEYS	FROM BULLETIN 32	
		AVERAGES	EXTREMES
Cumberland Plateau	0	4	4
Appalachian Valley	0	5	1–14
Blue Ridge	0	2	0–3
Piedmont region	5	6	1–14
Fall-line sand hills	6	8	7–10
Blue marl region	3	8	1–13
Southern red hills	7	11	4–20
Lime-sink region	7	17	8–31
Wire-grass country	7	25	4–37
Hammock belt	11	32	16–60
Flat pine lands	10	66	53–80
Coast strip	34	66	60–70
Highland average	4	5	
Coastal plain average	9	28	
State average	7	21	

About half of Bulletin 32 is a tabulation of the swamp lands, or "lands needing drainage," by counties. The wet lands are divided into several classes, such as permanent swamp, periodically overflowed land (bottoms), swampy depressions (ponds, bays, etc.), wet grazing land (low pine land mostly), land needing underdrainage, and tidal marsh; though of course all these types seldom occur in one county. The percentage of all sorts of wet land in each county is given, and by combining the figures by natural regions some interesting results are obtained. Similar data can be derived from the government soil surveys, which now cover parts of every natural region in Georgia. The figures of Bulletin 32 may be taken as maximum estimates, for they cover all sorts of low land, while those from the soil surveys are near the minimum, because many types of soil that were classed as "swamp" or "meadow" in the early reports, some fifteen years ago, are now referred to definite series and types (e. g. Myatt fine sandy loam, Ocklocknee silt loam).

The accompanying table gives the results of the computation for each of twelve regions; first the aggregate of "meadow," "swamp," and "marsh" as given in the soil surveys, then the corresponding figures from Bulletin 32, and finally the lowest and highest county percentages from the same publication, to show the range of variation within a region. The true regional averages depend on one's definition of swamp but are evidently somewhere between the figures in the first two columns.

While these figures cannot be depended upon absolutely, as already indicated, they show at a glance the increasing swampiness with decreasing altitude and relief and increasing proportion of summer rain. Similar statistics for other states, particularly neighboring ones, would doubtless illustrate the same principles. (For data on swamps for six divisions of North Carolina and nineteen of Alabama and West Florida, computed from soil surveys, see *Journ. Elisha Mitchell Sci. Soc.*, Vol. 33, p. 118; *Soil Science*, Vol. 4, 1917, pp. 105–106.)

ROLAND M. HARPER

EUROPE

The Port of Riga. In a recent number of *Meereskunde* (No. 152, 1919) Richard Pohle sketches the growth of the town and port of Riga. Riga is described as being not a part of eastern Germany but rather an outpost of German culture. The neighboring region on the north exhibits the typical landscape of a dune country. On the south it is moorland. The

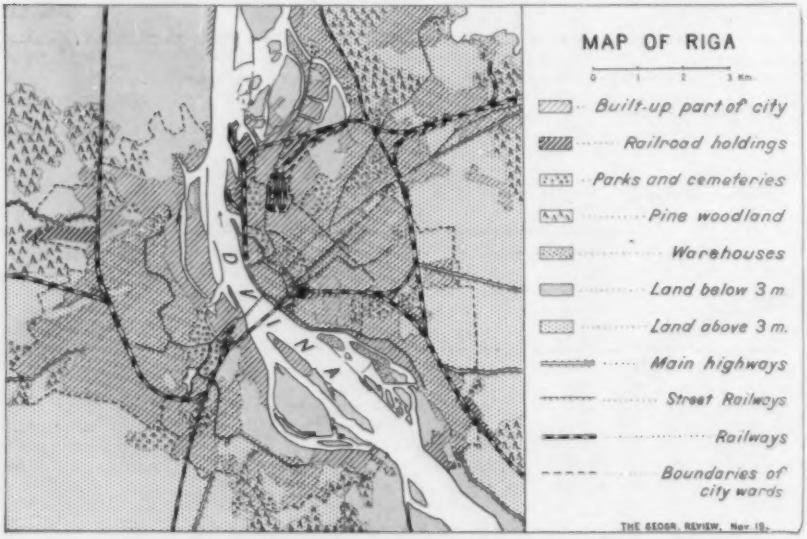

FIG. 1—Map of Riga (redrawn from Figure 6 of the paper discussed in the text).

Riga region is on the edge of the great forest belt of northern Russia. By its position at the head of a deep bay the city early became a central trading town. London, Flemish, Dutch, and German merchants came thither for the trade with Moscow. In 1280 Riga became a Hanseatic town and soon grew to be a factor in the commercial world. But through its settlement by German colonists and knights of Christian brotherhoods it was always more closely associated with Germany than any other state until modern time. At various periods it was commercially dependent upon Lübeck and Hamburg. The Polish overlordship was succeeded by Swedish control in 1621. The eighteenth century saw the gradual advance of Russian power to the Baltic.

The physical aspect of the city was entirely changed during the nineteenth century. In 1860 its walls disappeared. From 1875 to 1896 its port was practically rebuilt. From 1867 to 1897 its population increased from 103,000 to 281,000. Letts constituted 42 per cent of the population in 1897, Germans 25 per cent, Russians 17 per cent. German, Lettish, and Esth Protestants made up 63 per cent of the population, Catholics 10 per cent, Jews 8 per cent. The rest were composed chiefly of Greek Orthodox and Uniats.

In former times the harbor of Riga was frozen from two to three months a year, but ice breakers have reduced this to a month at the most. Of the total tonnage (nearly two million net registered tons in 1912) about one-fourth was Russian, less than one-fifth German, one-sixth British, one-ninth Danish. There is a considerable river commerce tributary to Riga. The valley of the Dvina had the first and most important railway into the Russian

empire. At the present time three principal Russian railways converge at Riga, and they tap the region extending from the northern forest country across the black earth belt and into the steppe region. A map (Fig. 3, p. 27) shows the hinterland of the Baltic ports of Russia and especially the rail hinterland of Riga. In 1913 the Baltic ports handled 40 per cent of the exports and 47 per cent of the imports of all Russia—Riga alone taking care of 17 per cent in value of the exports. Thanks to its transit trade the city has been since 1896 the most important export port of the Russian Empire.

Two other extremely interesting maps accompany the paper. They show the divisions of space in and about Riga. We reproduce one of them as an example of the geographical treatment of a city (see Fig. 2 on p. 35). The paper contains an analysis of the various city elements with a description of the characteristics and functions of each part in terms of the origin of the materials of commerce and life of the city. The author has worked out an unusually interesting analysis of the surroundings of a city and its internal structure and functions.

Population Distribution in the French Alps. A very complete geographical monography of the French Alps is promised through the work of the Institut de Géographie Alpine of Grenoble. The latest contribution towards this end is a study of population distribution by Jean Robert (La densité de population des Alpes françaises d'après le dénombrement de 1911, *Rev. de Géogr. Alpine*, Vol. 8, 1920, pp. 5–124). The author's viewpoint is important. "The density of population is as it were the synthesis of all the geographical phenomena: it expresses eloquently the manner in which man has taken advantage of the land he occupies."

This conception leads to the principle adopted for the expression of population density. It is determined not according to the total land area but according to the "exploitable" area. The unutilizable spaces—the snows, glaciers, rock peaks—are excluded. The method of arriving at this area is interesting. For detailed analysis of such a feature as population distribution in such a region it is inadvisable to use an arbitrary limit such as the 2,000-meter line adopted by Blanchard in the determination of the mean altitude of the natural regions of the French Alps (*Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 7, 1919, pp. 245–308). On the 1:50,000 maps, with the aid of supplementary sources including photographs, were traced the upper limits of the forests and pastures including all features that appear susceptible of human utilization. An example will illustrate the significance of this method of expression. In the northern Alps the central massifs have a population of 28 per square kilometer (72 per square mile) in relation to the exploitable surface, of 15 (38 per square mile) only if the total surface is considered. Thus proportionally in spite of the high altitude they support a population as great or slightly greater than the lower, richer region of the pre-Alps (27 per square kilometer). The central massifs make the most use of the abundant pastures, the pre-Alps suffer from inaccessibility and the superior attraction of adjacent regions. The hydroelectric establishments for instance are all on the periphery of the pre-Alps, if not entirely beyond its borders, and distribute power to the neighboring valleys with little profit to the mountains. A table of the exploitable areas by natural region and by commune is given at the end of the article. It might advantageously have been paralleled by the total areas; for, after all, the unexploitable area has a significance if merely of negative character.

The first question of expression settled, the second that arises is the disposition of the rural and urban populations. Urban population is here considered as that residing in agglomerations of over 3,000. In subtracting such from the total figure an allowance of 3,000 is made for each agglomeration.

The large scale map (1:3,000,000) on which results are shown is a "mosaic," the author considering the "speaking" qualities of this to be greater than the isometric form for a region where the contrasts between neighboring communes are often very sharp. There are, for instance, scantily peopled communes of the Chartreuse massif where, chiefly through monastic influence, 20,000 hectares of woodland has been preserved, side by side with the densely peopled communes of the Grésivaudan valley.

A small map shows distribution by natural regions. There is a clear though progressive distinction between the northern and the southern sections, the division being the climatic line recognized by E. Bénévent (La pluviosité de la France du Sud-Est, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 1, 1913, pp. 323–442), which may here be approximately described as the divide between the basins of the Isère and the Durance. The average density of the northern section is 40 to the square kilometer (103 per square mile), 55 (142) if cities be included; for the southern section it is 17 (44), 19 (49) with the inclusion of cities.

The mean altitude of the southern Alps is lower, but in other respects it is less favorable to human occupation than the northern region. Structure, relief, and the nature of the rocks make a country more broken and difficult of access. In addition to this are climatic disadvantages. Dryness of the limestone areas is accentuated by less abundant

precipitation. Alluvial and glacial deposits are more scant. There is nothing in the south comparable with the dense population of the transverse gorges, *cluses*, of Faucigny, Annecy, Chambéry, Grenoble, and the subalpine depression of the north. The nearest approach is in the depression of the Durance, where some progress has been made in the line of industrial development. On the contrary the disproportion between north and south diminishes at higher altitudes. It is noteworthy that here the most fully occupied, if not the most densely peopled, zone is that from 400 to 1,000 meters.

The population map also includes certain bordering regions. Thus the Riviera is included, though strictly it is extra-Alpine. There is a close relation between the Côte d'Azur and the mountains to whose protection its marvelous climate is due. The population density (total) of the narrow strip is 503 to the square kilometer (1,300 to the square mile). It is impossible to separate the rural and urban elements, for most of the agglomerations have more than 3,000 inhabitants.

AFRICA

A Phase of the Racial Problem in South Africa. In the intensive study of the distribution of the white man in South Africa, and of the relation of that distribution to native races, important data may be obtained from the paper "The Transition from Tribalism to Individualism" by J. R. Kingon (*South African Journ. of Sci.*, September, 1919, pp. 113–157). It deals chiefly with the change now taking place in the tribal system of government of the natives and sets forth the various factors that operate in the evolution of the native peoples of Kaffirland where, before the white colonists came, the natives lived a pastoral life, moving about with their herds from place to place in search of pasturage and cultivating small gardens for immediate needs. Their wealth was represented by cattle, sheep, and goats. Corn and sugar cane were among the products of the gardens. Flexibility in physical arrangements was a principal object so that the tribe could flee at a moment's notice and take its cattle to a place of safety.

Only when the white man came into the region was this general economic system seriously changed. The white man set up a border zone to the east of the colony. This however was transgressed by the native to the confusion of the white settlers. He drove off the cattle of the farmers and kept the country in a constant state of unrest. After various less successful expedients had been tried a chain of forts was built along the frontier at intervals, and by signaling between forts the military were able greatly to reduce cattle stealing. With the extension of the colony eastward more and more of Kaffir territory was absorbed by the white man. In 1820 British settlers began to arrive and were established in the eastern part of the colony. The inclosure of farms commenced and the native found himself more and more limited and inconvenienced. If he stayed on his farm, he had to pay rent; if he moved off it, he had to go to the native reserve or settle wherever he could on unoccupied lands. Side by side with these limitations in the occupation of land and the number of his flocks and herds other factors operated.

Formerly the native lived in a state of tribalism, the cementing principle of which was witchcraft; he accepted the principle of communism in land and of complete responsibility to the tribe from the standpoint of customs and ownership of property. He now found himself forced to accept the principles of *individualism* and *private property in land*. In his education through missionary agencies he acquired a new psychology. The opening up of roads favored the spread of the new ideas. Many trading stations were established. Periodical fairs were instituted, the most important being the one at Fort Wiltshire (Willshire) in 1824. The reports of local British officials for 1910 and 1912 show a rapid increase in the number of trading stations, the volume of goods, and the effect upon the native in development of the wealth of his country and his way of life. European clothing has been adopted, dwelling houses improved, flocks and herds increased, and there has also developed an export trade in wool and hides.

The effect of these changes upon the native way of life is perhaps equally clearly seen if we turn to two examples of the former "accidents" that affected him. Tribal wars have been greatly reduced. We do not have in recent times a repetition of such wars as that which terminated in 1835 (that extended over a period of about 18 years) and which destroyed about one-half the population of an immense region west of Delagoa Bay. Formerly the native herds were devastated by drought. The effects are now ameliorated somewhat. In 1912 the cattle fever broke out among the herds of the eastern coast and wrought such havoc as to affect the supply of milk. Plowing was cut down, and the subsequent harvest reduced. With continuing drought and the drying up of the pasturage the animals died in large numbers. For long a state of exigency existed in the matter of food which would surely have led to very great mortality had it not been for the better organization of the present in the matters of transportation and relief.

ASIA

Explorations in Inner Arabia. On current maps of Arabia the unexplored central upland of the southern Nejd is represented as trending in a direction west of north, and the main drainage lines are made to run northeast. Of the people we have hitherto known very little, and almost all of that came into the literature secondhand. Sadlier, in 1819, was the first European to cross Arabia from sea to sea and one of the first to reach Nejd. Only a few explorers, mostly English, have since penetrated any portion of the vast interior. Permanent water pockets were reported and substantial resources were supposed to exist; for there were many towns, and the native Wahabi warriors gave frequent proof of their power. They have always led a wholly independent political life and have never been conquered throughout history. Doughty's admirable "Travels in Arabia Deserta" (1888) and Hogarth's "The Penetration of Arabia" (1904), have long been the standard writings on the subject. As late as 1904, according to Hogarth, a descriptive geography of Arabia by Ritter, published in 1845, was still a first-rate authority for nearly a million square miles of that country, so inaccessible had it been for modern explorers. Of the great southern desert we knew "about as much as Istakhri knew in the tenth century" according to the same authority, who estimates that not a hundredth part of the peninsula has been mathematically surveyed. In 1909 Carruthers made a remarkable journey in northwestern Arabia which was described (Douglas Carruthers: A Journey in North-Western Arabia, *Geogr. Journ.*, Vol. 35, 1910, pp. 225–248) in a manner worthy of comparison with Doughty's best. The Southern Nejd has recently been explored by Philby who has given a striking picture of the physical and human geography of the region. Philby's account is accompanied by a map showing detailed locations and relief (H. St. J. B. Philby: Southern Najd, *Geogr. Journ.*, Vol. 55, 1920, pp. 161–191). It seems as if this vast desert region (Arabia is more than a third as large as the United States) were being conquered piece by piece by men of exceptional character, the literary quality of whose writings reflects the fine spirit of their extraordinary feats.

The central geographic feature of inner Arabia is the Tuwaik, an upland belt 400 miles long with an average breadth of 20 miles, falling off steeply to the west and gently to the east after the manner of a cuesta. Through it run eastward-trending drainage lines, and about it and in favorable spots within it are groups of oases "which alone give the Arabs a respite from the nomad life." East of it is a barren desert which extends from an elevation of 2,000 feet above sea level to the coast of the Persian Gulf. Westward the Tuwaik is also flanked by sand deserts. To the south is a desert that has never been traversed by a European, a wide expanse of waterless country which includes the so-called Empty Quarter. Surrounded by regions difficult to cross, the central upland is the home of the Wahabis who are hostile to all about them and have within themselves suffered dissension and war.

The towns are of course closely connected with the drainage lines. One of the most interesting is the oasis of Hair. The population of four hundred consists entirely of people of negro descent who cultivate the groves and fields for the absentee owners—Bedouin tribes that visit the oasis but once a year at the date harvest to collect their rents and also during the month Ramadan "if it falls in the summer season." In one oasis, locally known as "the Wadi," the nomadic dependents of the oasis "retain their proprietary rights in the palm groves while wandering with their flocks and herds in the sand deserts to the north and south." There is the once important city of Yamama which appears to have been destroyed by a flood. The site is now occupied by a straggling village in the angle between two stream channels. Other towns suffer even today. In at least one wadi water flowed in 1917 where it had never flowed before within the memory of man, working havoc with the oases along the course of the channel and taking heavy toll of human lives, camels, and sheep. One of the temporary but inconvenient effects of such a flood is to fill all the village wells located along the gravelly floors of the dry stream beds.

Hauta is hemmed in by high cliffs and with its date groves, corn lands, and deep wells is both self-supporting and impregnable. No Arab force besieging it could long sustain life in the arid desert about it. Today Ibn Saud, Chief of the Wahabis, allows this town complete political autonomy, receiving only a small tax by way of recognition. Many new Wahabi towns have sprung up throughout the country in the last decade as a result of a vigorous religious revival known as the Ikhwan movement. The scattered character of the settlements has made it difficult to keep them in a state of political coherence, since there is no effective rallying point in which discipline can be taught and strength accumulated for wide conquest. The present ruler has made a dozen towns and villages of recent growth centers of military, political, and religious power.

One of the interesting minor pieces of information relates to the trade that crosses the region from the east-coast ports of the Persian Gulf to the west-coast ports on the Red Sea—piece goods, tea, sugar, and groceries passing westward in exchange for the coffee of Yemen.

Of different character but of first importance is a recent paper on Arabia by D. G. Hogarth (War and Discovery in Arabia, *Geogr. Journ.*, Vol. 55, 1920, pp. 422–439). The paper is a summary of recent explorations in their bearing on two chief points: (1) the character of the watershed between the northeastward-flowing drainage of the back country of the Hedjaz and that of the Red Sea slope; (2) the longitudes of inland points of the Hedjaz. A rather large body of data on these two matters was gathered under the severest handicaps chiefly by army officers during the war. The information is sufficiently full to permit the representation of the main topographic outlines of the western fringe of Arabia with approximate accuracy. The paper is illustrated by a map of the Hedjaz (which now takes precedence over earlier ones in the matter of more accurate representation of towns and drainage lines), and by photographs of Medina, including a unique airplane photograph of part of that city.

GEOGRAPHICAL NEWS

Plan of the Bicentenary Expedition to the North of Greenland. In the year 1721 Hans Egede left Copenhagen for Greenland; with this event was started the systematic

FIG. 1—Map showing Lauge Koch's routes in northern Greenland. For an outline of Koch's work in 1916–1918 see "The Second Thule Expedition to Northern Greenland, 1916–1918" and "Scientific Results of the Second Thule Expedition to Northern Greenland, 1916–1918," *Geogr. Rev.*, Vol. 8, 1919, pp. 116–125; 180–187.

colonization of the vast Arctic territory by Denmark. In celebrating the bicentenary of this colonization it is natural not only to review what has been achieved but also to look forward to what still remains to be done both in administration and in research.

The whole coast line of Greenland is now known. Every point of the coast, extensive as that of a continent, commemorates by its name the glorious achievements of some explorer. As a rule the greater nations were ahead of Denmark as far as the discovery itself was concerned, but it may safely be said that Danish research has always deepened and perfected the knowledge of the new coast lines. Stubbornly and unweariedly the Danes have carried their flag to the north on both coasts.

The coast of Peary Land, the remotest, most inaccessible part of Greenland, has been reached from both sides. The Denmark Expedition reached as far as Peary's cairn on Cape Bridgman; and the Second Thule Expedition, in which I myself took part, reached De Long Fiord. In this region there still remains a stretch of coast that no Dane has ever seen; and the interior of this country (Peary Land), almost as large as Denmark, is still absolutely unknown.

On the Second Thule Expedition, conducted by Knud Rasmussen, it fell to myself not only to map out great ice-free territories, which had hitherto been unknown, but also to demonstrate that geologically these new territories are among the most interesting in Greenland and that the so-called Caledonian Fold, which had hitherto been known to exist only in northern Europe, stretched across to the other side of the Atlantic.

Although these results are irrefutably proved by the collections which in spite of the greatest difficulties we succeeded in bringing home, I realized even while I was working in the field that great problems still remain to be solved. Another expedition was planned whose aim was to be exclusively geological and geographical research.

A headquarters with a wintering station is to be established in Robertson Bay in Inglefield Gulf. From here I am to start on the following journeys:

1. A large provision cache for future journeys is to be taken across the inland ice from Inglefield Gulf to Warmings Land, south of Sherard Osborn Fiord. (The writer's map of the regions surveyed by the Thule Expedition has been printed and will soon be published.) Its transportation will take place in the late summer, when the temperature is comparatively high and the surface snow is melted down or compressed. For this purpose Cleveland tractors will be used, as they will be able to work across the ice-free marginal zone at Inglefield Gulf.

2. The next year the same journey will be repeated in dog sledges to the cache and from there to the interior of Peary Land and to the North of Adam Bierings Land, an advanced base being established in Valmuedalen. From here various short journeys are to be taken: to Independence Fiord, where Mylius Erichsen's account of his journey is to be fetched, and northwards to Böggild's Fiord. On the way back the part of Wulff's Land and Warmings Land that I did not succeed in mapping on the Second Thule Expedition will be surveyed. The main cache will be passed on the way back in August.

3. The following spring I shall proceed from headquarters along the coast, through Robeson Channel, and further to the north of Peary Land into Independence Fiord.

From here I go on to my main cache, from which I start on the homeward journey.

My Danish companion on these travels will be Mr. C. F. Slott, an engineer who during many years and in many countries has devoted himself almost exclusively to the study of tractors and their practical working. On the sledge journeys I shall be accompanied by polar Eskimos.

The cost of the expedition is estimated at 110,000 Danish kroner, part of which has been guaranteed by the Danish Government. The remainder was raised by a committee under the chairmanship of Mr. C. F. Wandel, former Rear Admiral of the Royal Danish Navy.

The Government has also placed a ship at our disposal to take the expedition and its stores to Inglefield Gulf. This ship left Copenhagen on July 15, 1920.

LAUGE KOCH

GEOGRAPHICAL REVIEWS

Antwerp and Its Economic Significance for Switzerland

V. Bierkens. **Le Port d'Anvers: Son Avenir, Son Importance Economique pour la Suisse.** Maps, bibliogr. *Bull. Soc. Neuchâteloise de Géogr.*, Vol. 28, 1919, pp. 5–208.

This monograph was written during the first years of the war, when the author was an exile in Switzerland. He offers an apology for the restrictions imposed on him by the conditions but needs to make none; he has gleaned excellent material from different fields, has wrought it into a consistent whole, and has made a substantial contribution to the commercial geography of central Europe.

The first part of the study, making somewhat less than half, covers the port of Antwerp. The author describes the situation and equipment of the port and the projects for its improvement, with sketch maps which indicate roughly conditions as they were in 1914 and plans for the future. There follows an analysis of the trade of Antwerp compared with that of its competitors. The most important economic advantage possessed by the port lies in the relative equilibrium of its imports and exports. The figures for 1912, for Antwerp and its two most serious competitors, were as follows:

	Antwerp	*Hamburg*	*Rotterdam*
Imports, tons	10,080,000	16,648,000	20,850,000
Exports, tons	8,076,000	8,109,000	5,990,000

Thus the tonnage of wares offered for export at Antwerp amounts to four-fifths of the tonnage of imports, as compared with one-half or one-third at the other ports. In bulk the correspondence of imports and exports is even closer. Furthermore, the highly industrialized region of northwestern Europe provides a remarkably varied assortment of freight, of which some is suited to tramp steamers and some to regular liners. All these factors contribute to attract shipping, to lower freights, and to secure good service.

The most direct competitor of Antwerp is Rotterdam, which has enjoyed an immense increase of trade since the cutting of the Nieuwe Waterweg which has provided a deep channel from the Hook of Holland to the quays. The single factor counting most in favor of Rotterdam is, of course, the continuation inland of its waterway by the Rhine; and it is natural that Antwerp should seek to divert to its docks part of the great current of trade flowing up and down the river valley. The natural connection by the eastern Scheldt is barred by the embankment of the Dutch railroad from Flushing, and the connection now afforded by the canal Wemeldingen-Hansweert is unsatisfactory in several respects, of which the extended mileage is but one. In a chapter of thirty pages the author discusses the problem of grafting effectively the traffic of the Schedlt and the Rhine. He dismisses as impracticable the idea of a heavy duty freight railroad (*Massengüterbahn*). In view of the relatively short distance and consequent high cost per mile of transshipment, and of the impossibility of linking such a line to the existing railroad systems, he is undoubtedly right.

Of projected waterways he discusses four. For economic and political, as much as for technical, reasons he surrenders the hope of gaining for Antwerp the trade of the lower Rhine and of the Westphalian district, and he believes that the only feasible project is that of Schneiders, for a canal of three meters depth, floating boats of 2,000 tons, from Cologne by Aix-la-Chapelle, Maastricht, Hasselt, and Aerschot to the Brussels-Antwerp canal. This plan would surrender to Rotterdam all the Rhine trade up to Düsseldorf but would allow Antwerp to compete for the trade of the middle and upper Rhine and would tap the coal regions of Aix and Dutch Limburg. The economic arguments advanced in support of this plan appear to be sound. The technical difficulties, however, which would be involved in the construction and operation of a canal crossing a crest 145 meters above sea level need only be suggested. Even in 1914 the estimated cost of construction was put at 100 million francs, and the actual cost would certainly have exceeded that figure by an indefinite amount. At the present time the project must be dismissed as chimerical. The world cannot afford to invest its scanty fund of available capital for the construction of artificial waterways to compete with rivers that serve the traffic perfectly well. Antwerp would get some benefit by the canal, although the estimate of an annual traffic on it of four million tons appears extravagant. But it would certainly be impossible now to find investors or even taxpayers who would provide the money necessary for this scheme to attract trade out of its natural channel and over a hilltop.

In the second and larger part of the work the author discusses the trade of Switzerland in general and Swiss trade by way of Antwerp in particular. He distinguishes two separate zones, making up together Antwerp's commercial hinterland. The first, which he terms the Franco-Latin zone of penetration by land, comprises the North and East of France and parts of Switzerland and of Italy; this is served mainly by railroads. The second, the Germanic zone, depends on the artery of the Rhine; it reaches into Germany and Austria and touches Switzerland but finds its limits at the headwaters of navigation. Both zones are capable of extension. The opening of the tunnel of Moutier-Granges, connecting with the tunnels of the Lötschberg and the Simplon, will facilitate the penetration of southern Switzerland and upper Italy; and the author dreams of an extension of Rhine navigation to the Lake of Constance with branches linking the lakes of Zürich and Geneva.

In this, as in the first part of the work, the author shows the enthusiasm of an advocate rather than the measured deliberation of a judge. One hears him always crying, "This way to Antwerp!" His good faith is above question. He states with frankness and in full the reasons why a larger proportion of Swiss trade does not pass by the Belgian port. His analysis of the commercial relations and interests of Switzerland is excellent. His discussion of commercial policy and of transportation policy is well informed and interesting. Anyone who reads the book will profit by its compact and lively description of European trade as it was before the war. Only when the author begins to argue that European trade currents should change their course, and particularly that more Swiss trade should flow through Antwerp, will the reader be inclined to reserve judgment. The war has so far dislocated the commercial mechanism that prophecy now seems fruitless. As a record of the past, at least, the study has permanent value.

CLIVE DAY

THE ITALIANS IN SWITZERLAND

HEKTOR AMMANN. **Die Italiener in der Schweiz: Ein Beitrag zur Fremdenfrage.** 48 pp.; maps. Ernst Finckh, Basel, 1917. 8½ x 5½ inches.

The new boundaries of Europe follow rather closely the language frontiers (often wrongly called the ethnic frontier), and provision is made for a still closer approximation of new boundaries to lines of language and nationality. For example, Germany and Poland have signed a treaty which corrects the boundary between them as laid down in the treaty of Versailles, small Polish districts in Germany being traded for German districts in Poland. Again Greece and Bulgaria are permitted to exchange their respective nationals. In addition, almost all of the territorial transfers carry with them a provision that citizens of different language from the prevailing one may choose to move out of the country in which they find themselves and into the country of their own speech.

These provisions and circumstances set in relief and increase the importance of future movements of population of an opposite kind. One of the most striking cases is the strong Italian current that had set toward Italy in the years before the war and which will doubtless be resumed as soon as normal conditions are established. The author of the publication under review has made a thorough study of Italian emigration to Switzerland. He finds that the number of Italians increased between 1888 and 1910 from 41,883 to 202,809. At first they came as workmen on the railroads and tunnels. With the rise of industry in Switzerland they were drawn to the large manufacturing centers. Later still, they settled in the smaller towns, and today they are to be found practically everywhere. When they first came to the larger towns, they were engaged principally in the leading industries; they are now found also in the smaller industries. In the smallest towns one frequently comes upon the Italian cobbler or tailor. The figures representing their growth in industry are truly surprising.

The paper is accompanied by two striking maps, one showing the distribution of Italians in Switzerland in 1880 when they were found chiefly along the line of the railway through central Switzerland and about the border of Lake Geneva; the second map, for 1910, showing them scattered broadly throughout the country. They have displaced Swiss labor in the textile mills and have furnished the labor supply for the large number of hotels as well as for the roads that have been built in Switzerland in the last fifty years in connection with the development of scenic features and tourist travel. They publish newspapers and periodicals in large numbers in their own language. They have their own churches and live in separate colonies. They do not willingly obey the health regulations, reluctantly send their children to school, furnish a greater number of criminals than any other element of the population, contribute toward social unrest of almost every kind, and do not tend to mix with the German and French elements of Switzerland. In addition, they retain an attachment for the home country that is far greater than in the case of the Italian in America. Nearly all of them come from northern Italy and return there frequently. They send 20,000,000 francs back to Italy each year according to postal sta-

tistics (their total savings exceed this amount), and in 1910 they imported about 35,000,000 francs' worth of foodstuffs of Italian origin. The author fears serious political consequences and compares the situation with that in South Africa where the English stream of colonization led through complex stages to the Boer War and English domination.

These changes have taken place in just the period when Swiss emigration has been heavy and in which the birth rate of native Swiss has declined, while the birth rate among the Italians is high. Unlike the Italians Swiss citizens who have gone to other countries have given very little financial or commercial support to the home country.

China: Her International Relations and a Sketch of Her Development

H. B. Morse. **The International Relations of the Chinese Empire. Vol. 1, The Period of Conflict, 1834–1860.** xxxix and 727 pp.; maps, diagrs., ills., bibliogr., index; **Vol. 2, The Period of Submission, 1861–1893.** xiv and 479 pp.; maps, diagrs., ills.; **Vol. 3, The Period of Subjection, 1894–1911.** xvii and 530 pp.; maps, ills., bibliogr., index. Longmans, Green & Co., London, etc., 1918. $8.50 each. 9 x 6 inches.

K. S. Latourette. **The Development of China.** xiii and 274 pp.; bibliogr., index. Houghton Mifflin Co., Boston and New York, 1917. $1.75. 8 x 5¼ inches.

Every student of Far Eastern affairs rejoices in the completion of Morse's monumental work, the first volume of which appeared in 1910. The painstaking character of that volume, whose every statement was supported by reference to original documents many of which had never before been published, gave the work at once a pre-eminent standing among the numerous books about China. The long delay in the appearance of the second and third volumes has been due in part, it is understood, to the illness of the author.

The volumes are supplied with excellent maps, and the text is profusely annotated with references to authoritative sources, among which are the unpublished letters of Sir Robert Hart who was either a counselor or participant for half a century in nearly every important transaction affecting the foreign relations of China.

The first volume covers a period extending from the appearance of the Portuguese in 1516 to the close of the second war with Great Britain in 1860. "The Period of Conflict" it is called, because with the taking of Peking in 1860 the active opposition of the imperial court to western intercourse was brought to an end. Volume 2 deals with the "Period of Submission," a period in which "the Chinese Government accepted submissively the results of the treaty settlement of 1858 and 1860" (p. v). Volume 3 covers the years between 1894 and 1911, styled the "Period of Subjection," during which China suffered from the aggression of Western powers and the Manchu dynasty declined rapidly to its fall.

The author has done well to make the war of 1894 between China and Japan the beginning of a new period, for it was that war which inaugurated the series of disasters that have led to the present deplorable state of affairs in the Far East.

The cession of southern Manchuria; the protest against it by Russia, France, and Germany followed by its retrocession; the compensation given to Russia for her good offices consisting of railway rights in Manchuria; Germany's seizure of Kiaochow Bay; Russia's lease of Port Arthur and Dalny; Great Britain's lease of Weihaiwei and enlargement of the territory of Hongkong Colony; France's lease of Kwangchow-wan; the declaration of spheres of interest and talk of partition which precipitated the "Boxer" rising; the heavy debt so demoralizing to her finances placed upon China in punishment; the Russo-Japanese war and the annexation of Korea; the capture of Kiaochow by Japan in 1914; the Twenty-one Demands and the conventions wrung from China in 1915, together with the protest against the Shantung clause of the Treaty of Versailles—are all closely connected links in a chain of events that have followed one another naturally as results of that unrighteous and unnecessary war of 1894 waged partly to silence domestic strife in Japan over desired constitutional reform and partly to gratify the ambition of the military party there for the enlargement of the empire and to win a standing among the great nations of the world.

But that war was also responsible indirectly for the birth of the reform movement in China, for the downfall of the Manchus, and for the establishment of the republic. In that respect, therefore, it may be considered a blessing in disguise.

The second book under review is intended primarily as a text for college students, but it will also serve the general reader as an introduction to more detailed studies such as that reviewed above. Professor Latourette, now of Denison University, was for some years a member of the Yale Mission at Changsha, in the province of Hunan, China, and since his return to the United States has continued his interest in China and in the general condition of affairs in the Far East, as is evidenced by this volume and its companion, "The Development of Japan" (reviewed in the August number of the *Geographical Review*).

It is no easy task to compress the history of four thousand years into the brief space of less than 300 pages, but the author has accomplished this task very successfully. "The Geographic Background of Chinese History" is the theme of the first chapter. China perhaps better than most countries illustrates the influence of geography upon history. Cut off from the rest of the continent by lofty ranges of mountains on the west and by great deserts on the north, and protected by the sea on the east and south, China, so long as navigation was dependent upon sailing vessels, was isolated from the rest of the world—though in ancient times there was a limited intercourse with the western world—and developed a civilization distinctively her own. Foreign influence was almost entirely unknown until the advent of Buddhism in the first century of the Christian era. Moreover the Buddhist missionaries came and went for six hundred years before the religion became firmly established in China. China's immediate neighbors were all less civilized than herself and naturally fell under her influence, all but Japan becoming her vassals.

It was natural, therefore, for the Chinese to look upon Europeans, upon their first arrival in China, as inferior to themselves, barbarous peoples who had not yet enjoyed the enlightening influence of the Middle Kingdom.

The early history of the old empire is passed over very briefly, but is presented in an attractive manner. The author avoids so far as practicable the use of strange names. For the benefit of those who may want them they are in some instances mentioned in the footnotes.

In referring to the origin of the Chinese people and their culture, which he regards as shrouded in obscurity, the author (p. 15) makes mention of the theory held by some that the Chinese came originally from the Tigris-Euphrates Valley. Attention is called to the curious parallels between Chinese civilization and that of the Sumerians.

The reviewer has discussed this question elsewhere but may state here that an explanation of the striking parallels between the two cultures is best found by assuming that both had a common origin in Central Asia, where as Pumpelly and others have shown, there are the remains of ancient settlements whose foundation in some instances must be carried back to 8,000 B.C. For thousands of years the gradual desiccation of that region has forced an emigration of peoples both eastward and westward, and the earliest traditions of the Chinese undoubtedly point backwards in that direction.

The author gives a passing glance at the influence of Greek art upon Chinese Buddhism (p. 46) which, as he observes, "has only recently been disclosed." The conquests of Alexander undoubtedly introduced Greek art into northwestern India and central Asia, and the sculpture of Gandhara shows us that the Greek Apollo was the model upon which the ordinary Chinese images of the Buddha have been formed. A Buddhist theology modified by Christian influence, teaching an immortality of happiness, found a much more ready acceptance among the Chinese than the pessimistic doctrines of the founder of Buddhism.

Attention is called also to the fact that the Chinese emphasize society as contrasted with the individual. "The will of the individual is subordinated to that of the group" (p. 88). It is interesting to note that contact with the West is rapidly destroying this feature of Chinese social organization, Christian missionaries emphasizing the responsibility of the individual. The matter has received considerable attention in certain Chinese circles where it is feared that the growth of individualism will tend to laxity in morals, since the chief sanction of the moral code in their estimation is the accepted religion, whose most striking requirement is obedience to elders and adherence to the practices of the ancestors whom they worship.

The recent history of China is treated as satisfactorily as can be expected in so brief a survey, but suffers here and there from the omission of details which are necessary to a correct understanding of the subject.

With respect to the seizure of the leased territory of Kiaochow and the presentation of the Twenty-one Demands, Professor Latourette says: "These demands [those relating to Shantung] would not only make Japan the successor of Germany in this wealthy and strategic province, but they would give her more than Germany had ever had" (p. 221). . . . "The effect [of the Twenty-one Demands] was to make Japan the dominant power in China, at least until the European War should be over. However, instead of leading to an alliance between the Japanese and Chinese, in which the latter should give themselves willingly to the leadership of the island kingdom and the two present a united front to the world, it aroused among all Chinese a helpless but bitter hatred of Japan" (p. 224).

Japan would seem to have missed the "opportunity of a thousand years" as some of her publicists have expressed it, in neglecting to win the confidence of the Chinese people by an immediate return of the captured port and its privileges to the Chinese government.

E. T. WILLIAMS

The Political and Economic Development of Central America

D. G. Munro. **The Five Republics of Central America: Their Political and Economic Development and Their Relations with the United States.** With introductory note by J. B. Clark. xvi and 332 pp.; map, bibliogr., index. Carnegie Endowment for International Peace, Division of Economics and History, New York, 1918. 10 x 6¼ inches.

With their settlements along the salubrious western highlands, thus facing the almost shipless South Sea, and barred from contact with European civilization by the monopolistic trade laws of Spain as well as by the untraveled, low, malarial forests of the eastern plains, the Central American countries received little stimulus to development from the outside world until long after independence. They are rich in minerals; they present great opportunities in tropical agriculture; they contain vast grazing lands. Within recent years an awakening has come. Interoceanic railways, projected water routes, the construction of the canal with the prospect of great markets at Panama, and, more recently still, the growth of an enormous trade in fruit along the Gulf coast, have given new life to these lands.

The purpose of the present volume is to contribute toward a fuller understanding on the part of the American people of the present economic and political conditions prevailing in these near-by republics. The author spent several months, not only in the large centers of population where white influence is strongest, but also in outlying sections of the country, visiting provincial towns and rural districts where aboriginal and mixed-race ideas and customs dominate, thus gaining an insight into the actual operation of the social, political, industrial, and economic systems.

Recognizing that the greatest obstacle to continuous progress is the lack of stable democratic institutions, the author ascribes this in part to *localismo* (which may be interpreted as the influence of a geographical medium which has tended to keep the countries divided into isolated sections), in part to their remoteness from the world's roadways, as also in a measure to the lack of racial homogeneity. He believes foreign interference in their domestic affairs, either to suppress revolutions or to support the military chieftain who happens to be in control, will never accomplish the ultimate object sought. The greatest possible help that we can give our Central American neighbors, in his opinion, is helping them to solve their social and educational problems that they themselves may overcome the natural obstacles to self-government.

The Primitive Civilizations of Peru

Carlos Wiesse. **Las civilizaciones primitivas del Perú.** 291 pp. Universidad Mayor de San Marcos, Tipografía "El Lucero," Lima, 1913. $1.00. 8½ x 5½ inches.

Although nearly seven years old this work is not so well known in North America as it deserves to be. Yet it is of great value, on the whole, to the student and to the teacher of American anthropology. In essence, it is at once a summary and an elaboration of the system of culture sequence founded by Uhle.

In his "Parte Preliminar" Dr. Wiesse discusses the question of geologic man in America. He accepts the findings of Hrdlička rather than those of Ameghino. In his discussion of the various phases of culture in America the terminology is unfortunate. Much is said of "paleolithic" and "neolithic" periods and cultures. To most North American anthropologists this classification will be distasteful because of the chronological element involved, an element quite out of place when attached to such cultures as those of the cliff dwellers, the mound builders, and the Changos. Some of the "paleolithic" cultures are extinct; others still exist. Another set of terms would have been better, and the classification of cultures itself is not above criticism, for the people of the shell heaps and the mound builders certainly do not belong in the same cultural category. Then, too, in his account of the historical development of the people in Mexico and Central America, Dr. Wiesse shows himself lamentably out of touch with modern research. On page 36 he says: "It is established that in the tenth century the Toltecs of the kingdom of Tula . . . marched to the east and then to the southeast, founding the cities of Palenque and Tixal (*sic*), then going north to the peninsula of Yucatán where the cities of Kabah, Uxmal, Chichen-Itza, Aké, Mayapan, and Izamal flourished." One is led to suspect that Dr. Wiesse is acquainted only by hearsay with the works of Brinton, Brasseur de Bourbourg, Bowditch, Spinden, and Morley.

From this point onward, however, the work is excellent, even though one may not wholly agree with some of it. The style and arrangement are above reproach. An admirable summary of Uhle's findings as to the earlier phases of the cultures of Chimu and Nasca is given. It is a pity that Uhle's dictum to the effect that the Nasca culture is the older should have been accepted so unquestioningly, but this is more than made up for by the very

able description (pp. 66–72) of the still earlier and more primitive culture of the first coast dwellers. As the book was written before Spinden had published anything on the Archaic Type, there is no hint of the real significance of these very early people. Dr. Wiesse makes the important suggestion that there was not only contact but strife between the earliest folk and the more advanced Chimu and Nasca successors, a suggestion vividly supported by the vase paintings of the Chimus, in which battle scenes between well-armed and unarmed warriors are frequent.

Further, Dr. Wiesse gives a succinct and valuable outline of the chief features and problems of the Tiahuanaco culture. The chronological aspect of the discussion merits special commendation for its reasonableness; especially important in this connection is what Dr. Wiesse says (pp. 93, 94) of Llojepaya, a group of ruins on the present margin of Lake Titicaca. These ruins are in the same style as those of Tiahuanaco, and they prove that the Lake did not reach to Tiahuanaco at the time the two sites were occupied. This is an effective rebuttal of Posnansky's pretensions that Tiahuanaco was a port. A full, perhaps unnecessarily full, discussion of the long-since discredited conjectures of Angrand as to the possible Toltec origin of the builders of Tiahuanaco is given and a very full and valuable account of the god Huiraccocha (pp. 104–121). This is followed by a helpful and stimulating description (pp. 121–149) of conditions on the coast and in the highlands in the times immediately preceding the Inca period.

Dr. Wiesse begins his account of the Inca period with an exposition of the sanest theories concerning the origin of the Incas. Following in the footsteps of Uhle, he concludes that the Incas were neither more nor less than a tribe who lived near Cuzco, who were descended from former subjects of the old Tiahuanaco empire and who gradually built up a new empire for themselves. Equally satisfactory and sound is the date chronology. There is an important account of the history of the growth of the Inca power. The division of the Inca period into a "feudal" and a "unified" epoch is suggestive, original, and convenient. The further division into "dynasties" may seem to some unnecessary and unwarranted. Following this is a wholly admirable summary of the component parts of the Inca dominion, enriched with many apt quotations from old chroniclers. Then, with the work of Saavedra, Belaunde, Cunow, and Uhle for a basis, Dr. Wiesse gives a reconstruction of the social organization of the Inca dominion. The book is brought to a close by an account of the physical and intellectual aspects of the Inca culture which, though brief, is exceedingly comprehensive and valuable.

With the exception of a marked lack of care in the spelling of foreign proper names, the book is well documented, authorities in plenty being quoted. It is a pity that such errors as "Bourborug" for Bourbourg (p. 131), "Prescot" for Prescott (p. 161), and "Wilson" for Winsor (p. 164) should be allowed to creep into bibliographical references otherwise so excellent. Despite the faults which have been noted, one may say without hesitation that the book should stand beside Beuchat, Joyce, and Markham on the anthropologist's work table. It is the best summary of Andean anthropology to be found.

PHILIP AINSWORTH MEANS

METEOROLOGY AND OCEANOGRAPHY OF THE ATLANTIC

Atlantischen Oceaan, Oceanographische en meteorologische waarnemingen in den, December, Januari, Februari, 1870–1914. With title in French: Observations océanographiques et météorologiques dans l'Océan Atlantique, Décembre, Janvier, Février, 1870–1914. 24 maps, with accompanying text. *Kon. Nederl. Meteorol. Inst.* [*Publ.*] *No. 110.* Seijffardt's Boekhandel, Amsterdam, [1918.] fl. 7.50. 20 x 18 inches.

There is a popular impression among teachers and students of meteorology that, the days of the sailing ship having largely passed, there is comparatively little interest or importance in the preparation and study of detailed charts and discussions of the meteorological conditions over the great ocean areas of the world. This is a highly mistaken point of view. While it is true that the fast passenger steamship is far less dependent upon weather conditions than is the sailing vessel, yet even the "ocean grayhound" has to meet and reckon with storms and ice and fog and is helped or hindered by the movements of ocean currents. Furthermore, the bulk of the world's commerce is carried on the slow-going "tramp" steamer, where high speed is not sought, and where the success of the "tramp" as a paying proposition is largely dependent upon making use of every favorable weather condition and avoiding, as far as possible, adverse winds, currents, and other obstacles to navigation such as fogs and ice. Thus, although the picturesque sailing ship is truly becoming more and more of a rarity, ocean navigation needs today, as it always has needed, the best possible information which can be supplied regarding the meteorology of the "seven seas."

The oceanographical and meteorological work of the Meteorological Institute of the Netherlands is well known. The observations made on board of Dutch ships during seventy years past have already furnished the basis for the preparation of valuable charts and discussions. One of the most complete of these publications deals with the Guinea Current and bears the date 1904. Other publications, for the most part covering the period of sailing vessels, have today less general interest. With the passing of the years the number of observations has decidedly increased, and, in consequence, it has become possible to determine, with greater and greater accuracy, the values of the various meteorological and oceanographical elements for the latitudes included between 50° N. and 50° S. The conditions over the Indian Ocean having already been discussed (*Publ. No. 104*), the next step was a similar discussion for the two Atlantic Oceans. The *Atlas* now before us is the first section, covering the months December to February, and is to be followed by sections dealing with the remaining months.

The observations dealt with were made mostly on Dutch vessels during the period 1870–1914, but data on winds and currents collected by the British Meteorological Office and the Deutsche Seewarte were also included for portions of the oceans where the observations made on Dutch vessels were few in number. The total number of observations employed was 1,562,463, covering currents, winds, pressure, air and surface water temperatures, and cloudiness. The reverse of several of the charts contains a discussion (in Dutch) of several matters which are of special concern to navigators, compiled by P. H. Gallé, assistant director, who, with Dr. J. P. van der Stok, had oversight over the preparation of the *Atlas*.

There are twenty-four charts in all. For each of the three months (December–February) we have the ocean currents; winds; isobars; isotherms for air and surface temperatures; sailing routes, storm tracks, fog and ice limits, and limits of the great wind belts. The frequency of directions of winds and currents is shown by "roses," the lengths of the different arrows indicating the percentages of frequency, while velocities, in nautical miles per hour for currents and on the Beaufort scale for winds, are shown by the number of barbs. The generalized currents and winds are shown on special maps by means of simplified arrows indicating the prevailing directions and velocities. Those who, for purposes of general information, desire only the larger facts will be especially interested in the three charts at the end of the *Atlas*, which show the sailing routes, ice and fog limits, storm paths, and the general boundaries of the wind belts.

R. DeC. WARD

INDUSTRIAL SUBURBS

G. R. TAYLOR. **Satellite Cities: A Study of Industrial Suburbs.** xviii and 333 pp.; maps, ills., index. (National Municipal League Series.) D. Appleton & Co., New York and London, 1915. $2.00. 7½ x 5 inches.

The author in his title has reference to the subsidiary centers of industry which have sprung up in recent years in the suburbs of our great cities. The book is one of the National Municipal League Series and is a critical investigation of the opportunities which the "made-to-order" cities possess and of the idealism which the science of town planning is trying to express. In its detail, it is a study of various types of satellite cities, Pullman, Norwood, and Oakley near Cincinnati, St. Louis' East Side, Gary, and Fairfield near Birmingham, Ala. The conclusion is reached that the factory gains by a transfer of its plant from a civic center to a suburban site; and this can be the more readily believed because in most of the manufacturing centers of the United States this movement has taken place and is gaining in force. The city is also the gainer in the relief from congestion.

The point of the book, however, is whether or not the people involved in the transfer are bettered or are exploited as industrial conveniences. Many cases of civic shortcomings on the part of the industrial leaders and the city authorities are instanced, and they lead one definitely to the conclusion that many of these satellite cities consider the problem of the laborer a secondary matter. In some cases the workman has found better living conditions; in more cases he is forced to commute or become the prey of building speculators. The problem of city planning is not solved—no attempt is made to point to a solution—but the book does in its clear presentation of the facts show the way definitely towards constructive progress.

ROBERT M. BROWN